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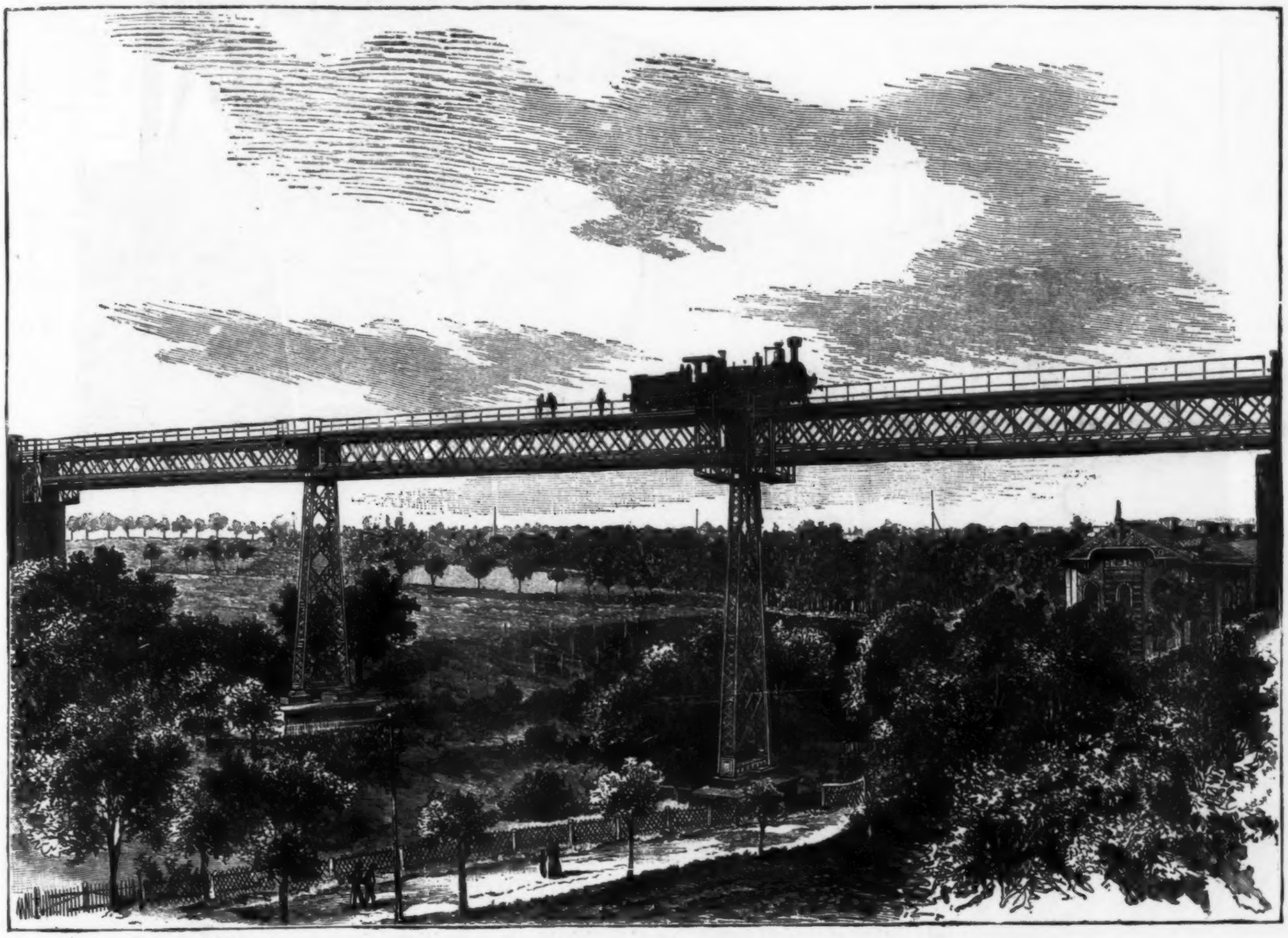
NOTABLE NEW RAILROAD BRIDGES IN SAXONY.

THE laying of the network of the "Staatsbahn" (government railroad) in Saxony has lately made it necessary to bridge over valleys and watercourses, and the light and strong structures used are well represented by the iron viaducts at Weida and in the Mittweida Valley. The former lies in a single track part, in the road between Mehlthuer and Weida. The principal feature in the history of this little railroad—it is only about 21½ miles long—is that twenty years elapsed between the beginning of work on the road and the running of the first trains. In the neighborhood of the little town of Weida, the most charming one in the "Voigtland," and across the line of the road above referred to, lies the Oschutz River Valley, which has an average width of 656 feet, and had to be spanned by a viaduct. A trestle bridge was decided on, the supports of which were made according to the system of Peterson, a Norwegian engineer. The columns are provided with joints or swivels, so as to allow for the contraction and expansion of the bridge caused by the variations of temperature, etc. The Oschutz Valley viaduct, which crosses the Oschutz River and the road from Weida to Gera at a height of 92 ft., is perfectly straight and level throughout its length of about 190 feet. On account of the shape of the valley, it consists of two parts, one of which spans the main valley by means of a continuous truss 330 feet long, composed of spans of 106 ft., 118 ft., and 106 ft. respectively; while the other, smaller part, is 177 ft. long, the separate spans measuring 59 ft. each. The two parts are separated by a central stone pillar, and other stone pillars support the ends of the bridge. The devices for compensating for the changes in the lengths of the trusses are in the middle column before mentioned. The track is of Bessemer steel rails on rolled iron sleepers. The wrought iron swiveled pillars are made of two members, which are rectangular in cross section and are connected by crossed braces. To prevent the canting of the pillars by strong wind they are firmly anchored to the foundation. A movable scaffold is provided for each span, so as to facilitate inspection and repairing. The entire cost of this structure amounted to about $48,480.

The other highly interesting structure, the Mittweida viaduct, lies in the single track or portion of the Annaberg-Schwarzenberg Railroad, and spans the valley at its deepest point. Each pillar consists of two strong members which are connected by horizontal ties and by horizontal and more or less vertical braces. The lower ends of the members form the corners of a square, while their upper ends are joined together to form a parallelogram, and serve to carry the track directly, the track running lengthwise of the parallelogram. The members rest on strong brick work laid in cement, which is built of a foundation of rock and is firmly anchored to the same. Between the pillars there are fish belly trusses, which vary in length. The track is of Bessemer steel rails, which rest on wrought iron sleepers. The arrangements which compensate for the variation in the lengths of the trusses are within the pillars. The bridge has very great stability on account of the light construction of the trusses and the large area of the anchorage. The entire weight of the structure is about 1,000,000 lb.—*Illustrirte Zeitung.*



NOTABLE NEW BRIDGES IN SAXONY—THE IRON VIADUCT AT WEIDA.

[FROM THE NEW YORK TRIBUNE.]

THE NEW CROTON AQUEDUCT, NEW YORK.*

IF any one thinks the aqueduct a dry subject, let him wait till June. It will be wet enough then. The reporter who made the first genuine and original trip through it found it rather too wet. Especially was it in that condition in Gould's Swamp siphon and in the great siphon under the Harlem River. Only a didapper could have made subterranean and subaqueous passage of those sections. As Deputy Chief Engineer Rice and the reporter dodged the former, so they passed over the latter, high and dry, each promising the other to explore both siphons when they are pumped out, in the course of the next two months. The previous installment of the reporter's account of his tour left the explorers at the mouth of shaft No. 23, out of which they had had a long and laborious climb, after a longer and more laborious wade down to shaft No. 24, the beginning of the great siphon, and back again.

It would have been less expensive to build a stone or steel viaduct to bring the water over the river than to bore a great hole through solid rock, 307 ft. below the tide, but certain advantages were gained by the latter method which, it is believed, will counterbalance its greater cost. Not the least of these is immunity from the danger of foreign attack. Should any foul invader at any time presume to invade this part of the country, and succeed in planting his cruel guns on Washington Heights, or at Spuyten Duyvil, or on Ward's Island, or if he should fire them from the starboard bow of men-of-war anchored at Harlem Bridge, what would be easier than to punch out the piers of High Bridge with a few big shells, turn the old aqueduct into the river, and bring us to terms with a water famine? For that matter, the old aqueduct is a helpless, defenseless sort of structure from beginning to end. Being a surface conduit, the enemy might destroy it in a hundred places with picks and shovels, to say nothing of shells from gunboats in the Hudson. New York cannot realize what a narrow escape it has had. Just think of leaving our water supply exposed in that reckless way all these years. If Hayti had only known!

The new aqueduct, armored with the hills, is practically out of reach of the foe. In case of hostilities there would be only four places to guard: the Croton gate house and the waste weirs and blow-offs at Pocantico, Ardsley, and South Yonkers.

The first design of the engineers contemplated a crossing of Harlem River at a distance of only 157 ft. below the water, but tests with the diamond drill exposed a crevice in the bed rock which extended many feet lower, and it was to avoid that that the siphon was carried down 307 ft.

"In our experiments," said Mr. Rice to the reporter, "we came across an extraordinary geological formation. One of our drills, passing from gneiss rock into limestone, brought up a core which showed the two strata to be firmly welded together. I had never seen or heard of such a thing before."

The siphon is a circular tube of brick, 10 ft. 6 in. in diameter, and the water in it is under great pressure,

* Continued from SUPPLEMENT, No. 742, page 11854.

At shaft No. 20, where the horseshoe section ends, the flowing capacity of the aqueduct is reduced from 318,000,000 gallons a day to 250,000,000, leaving 68,000,000 gallons to be turned into Jerome Park when the historic home of the defunct American Jockey Club shall have been converted into a reservoir for supplying the annexed district with water. The siphon having a smaller area than any other portion of the tunnel, the stream must flow through it much more rapidly than it flows elsewhere in order to keep the larger section south of the river up to its full capacity of 250,000,000 gallons. Plunging down shaft No. 24, the water sweeps under the Harlem to shaft No. 25, where it lifts itself into a great vertical column over 400 ft. in height. Then, breaking off abruptly to the horizontal, it climbs a gentle slope to the gate house at One Hundred and Thirty-fifth Street.

FOR CLEANING OUT THE GREAT SIPHON.

No. 25, one of the greatest shafts in the world, is, in reality, a double shaft. The siphon being the lowest part of the aqueduct, whatever sediment the water may contain will be deposited there, and it became necessary to provide a means of cleaning it out from time to time. Chief Engineer Fteley has designed an ingenious yet remarkably simple apparatus for the purpose. The two shafts are side by side, divided only by a stout wall of masonry, in which, at the extreme bottom, there is a gate, which, being opened, permits the water to pass from one to the other. The first shaft, a section of the aqueduct proper, is always full; the second, its auxiliary, is empty so long as the gate is kept closed. To clean out the siphon it is necessary to empty all that portion of the aqueduct between South Yonkers and One Hundred and Thirty-fifth Street. The first proceeding is to dam the water at South Yonkers. The next is to open the gate at the bottom of No. 25 and let the water pour into the auxiliary shaft. In this there are enormous buckets, which slide up and down with the speed of the wind, being held in position by bronze guides. They have valves in the bottom, which open as they plunge into the water and close when they are pulled up, filled to the brim. They travel so fast that the water has no chance to rise in the shaft, and the aqueduct is emptied in an incredibly short time. Pipes convey the waste to Harlem River. The apparatus is operated by splendid engines, designed for that especial purpose. The foresight shown by Mr. Fteley, and the care with which he has worked out the minutest details of the construction, are forcibly brought to mind in the arrangement of the gate. To the casual observer the rod by which it is raised and lowered is unnecessarily large and heavy. It is four inches square and weighs about eleven tons, while the gate itself weighs but one ton. Both are bronze, so that they will never rust.

"Suppose," said the chief engineer, "a block of wood were to float down the aqueduct and become fastened in the opening between the two shafts. With a weak, pliable rod we should be helpless. It would be necessary to pump out all the water and send a man down to remove the obstruction. With the large rod that we are using we are prepared for just such an emergency. It is rigid enough to force the gate through a log of wood, and I don't know but that a large bowlder might suffer if it should get in the way."

By a turn of the wheel controlling this gate an immense power is gained. The gate and rod together weigh 24,000 pounds, yet a pressure of twenty-five pounds on the lever is sufficient to lift them. A delicate child might operate the entire mechanism.

This blow-off may not be used once in ten years, yet it had to be built.

It was impossible to descend No. 25 on account of the water. Mr. Rice and the reporter did the next best thing—they went down No. 26 and walked back through the tunnel to No. 25.

"I'd advise you not to try twenty-six," said an inspector, who seemed to know all about it.

"Why?" said Mr. Rice.

"It's dangerous. It's as much as your life's worth to attempt it."

"I guess we can manage it. I've been climbing up and down shafts for twenty years."

"Well, if you're bound to go, you'd better let me send down a life line. It'll be some help. There are three or four places on the ladder where you'll have to do some mighty particular climbing if you want to save yourselves. I'd advise you to get on your knees and climb around them powerful slow and cautious."

There's no disguising it, the reporter was frightened. But Mr. Rice's coolness encouraged him. On the profile of the hill, in full view of the inhabitants, everyday clothes were exchanged for rubbers, which by this time had become familiar, and the perilous descent was begun. The mouth of the shaft was some five feet above ground, and the tourists had to climb up the outside before they could climb down the inside. It was a ticklish business going over that cope stone, and feeling about for the ladder with both feet. A slip meant—lethe. A descent of thirty feet brought the tourists to an iron platform, which covered an area the size of an ordinary room. Here they lingered while Mr. Rice explained to the reporter that he stood in the safety valve of the aqueduct. The upper part of the shaft is divided into two sections, from one of which large pipes lead to the river. A few feet above the hydraulic grade line the wall between the sections terminates. If, for any reason, the gate house at One Hundred and Thirty-fifth Street should be suddenly closed, the water in the tunnel would force itself up this shaft till it climbed this wall, over which it would flow into the escape pipes, doing no harm. But if the wall and the pipes were not there, something might burst. This safety valve is another illustration of Mr. Fteley's farseeing foresight.

DOWN A COLD AND DANGEROUS LADDER.

Leaving the valve, the descent began in earnest. The rungs of the ladder were as cold as ice, and the fingers were soon benumbed. It was impossible to retain a firm hold without occasionally hooking the elbow over a rung. The reporter paused frequently to prop himself in this way, so that he could blow his breath on his hands to warm them. The descent seemed to occupy him about six hours; as a matter of fact, it did not occupy him six minutes. Mr. Rice, who went first, frequently shouted back:

"Don't step on my fingers!"

The obstructions spoken of by the inspector were very troublesome. They stood out from the ladder horizontally, a distance of about fourteen inches, and the task of climbing around them, suspended between heaven and earth—or between earth and the bottomless pit—was terrifying. There were three of them, each more appalling than its predecessor. But patience and endurance conquered, and after many hardships the tourists stood on "sub-terra-firma," looking skyward at the lofty region through which they had passed.

A walk northward of 525 feet brought them to shaft No. 25, down whose solemn black throat they peered, imagining how it would feel to jump in and plunge to the bottom, 419 feet below. Then turning southward, they strolled toward the gate house at One Hundred and Thirty-fifth Street, two miles and a half away.

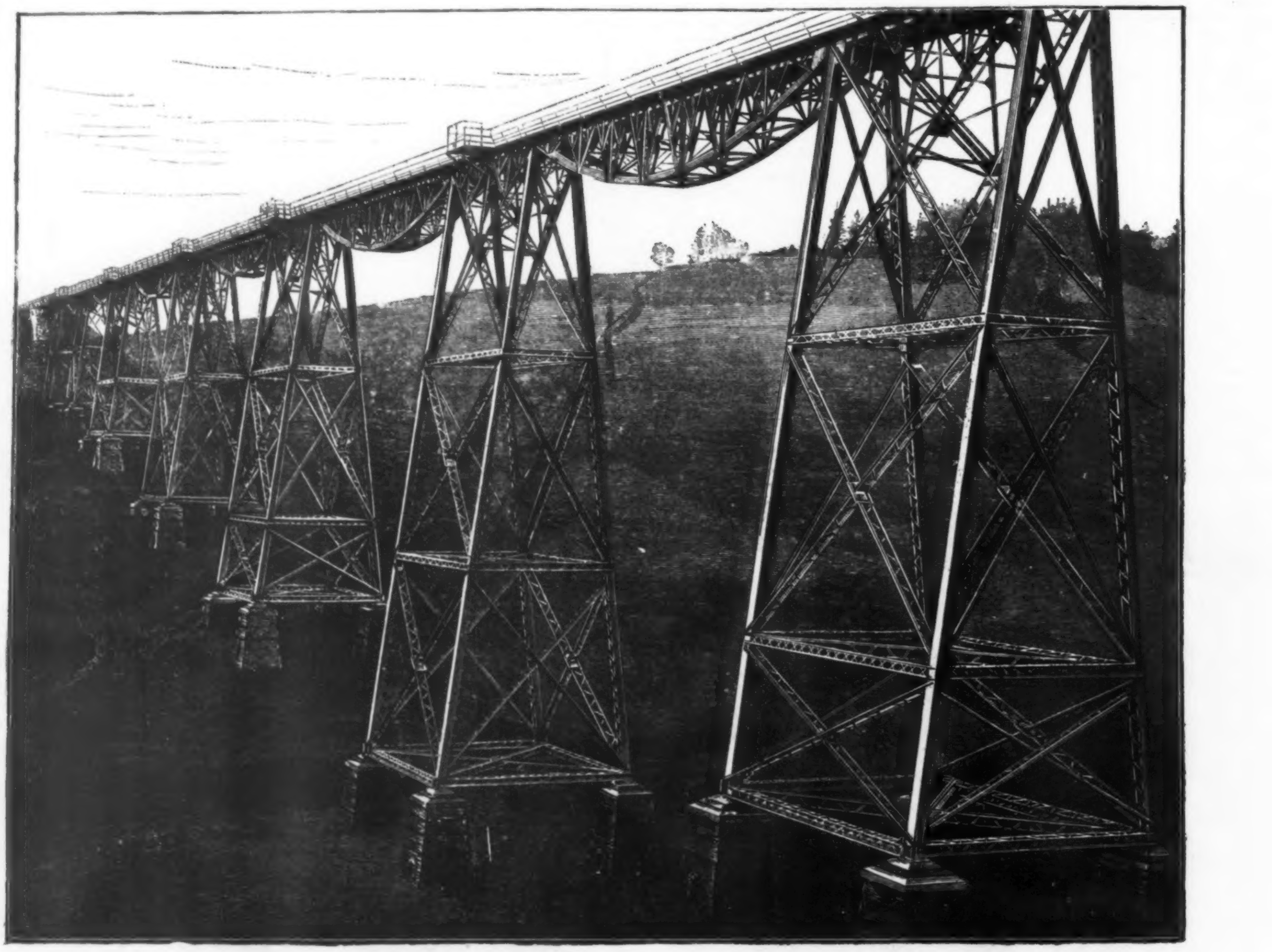
This part of the tunnel is round, twelve feet and three inches in diameter, and the tuning fork found it in the key of G. The upward slope from the river is gradual, only eight and two-fifths inches in the mile, except right at the gate house, where the grade is very steep for a hundred feet. As the tourists toiled on through mud and slime, which was thigh deep for nearly a mile—the worst walking on the whole line—the tunnel spoke to them. Its voice was clear and distinct, its language unmistakable. The sound of the splashing water, magnified a thousandfold, resolved itself into the key of G, and hummed and sang and pleaded for recognition. A cough, on no key at all, only a harsh, hacking cough, wandered and grew till it became a delicious chord in G. The scratching of a match, than which there is nothing less musical, became a melody in G. It was like a visit to enchanted regions.

"Here's where that workman was killed a few weeks ago," Mr. Rice said, and he began to look on the walls to see if a sign had been left. But even the blood had been washed away. The man had fallen down shaft No. 28.

Near shaft 30 the tunnel makes a reverse curve, the only one on the aqueduct. A short distance north of it is the "boiler," a section lined wholly with boiler iron, the ground being so soft and wet that it was feared the masonry alone might not be a sufficient protection against it. All the work south of No. 24 is under the charge of E. Wegmann, Jr., division engineer.

IN THE GATE HOUSE.

The beautiful gate house at One Hundred and Thirty-fifth Street was reached at noon. The tunnel bores rapidly upward, bringing the tourists in the light of day at the bottom of shaft No. 32. This is simply an overgrown well, provided with a ladder, up which the climbing was easy. At its mouth a magnificent stone pier rose up, with grooves on either side for the reception of stop-plank. The stop-plank system on the aqueduct seems very extensive. Passing to one side of the



NOTABLE NEW BRIDGES IN SAXONY—THE MITTWEIDA VIADUCT.

pier, the tourists stood in a grand and lofty chamber. The northern wall was flat and bare. Against the southern, six great pillars stood up, side by side, mammoth sentinels guarding eight big gates, behind which the reporter obtained glimpses of eight monster pipes, gaping with thirst.

The tunnel had ended; the pipe line had begun. A ladder at the west end of the chamber led upward to a smaller apartment. Here the tourists entered a small hole in the ground, in which they had to duck their heads, and journeyed in a northwesterly direction for some 300 ft., when they came to a solid wall.

"This tunnel," Mr. Rice explained, "connects with the old Croton aqueduct in Tenth Avenue. It is but a few feet away. When the new aqueduct is opened, this wall will be pierced, and the old stream will be turned into the gate house."

How insignificant the little tunnel was in comparison with the great hole through which the reporter had been journeying for twenty hours! The new aqueduct would hold about four of the old. As the old stream is turned into the gate house, so it is again turned out and back into the old conduit through pipes leading from the small upper apartments. The diversion is simply a matter of economy and convenience. It will do away with the ugly old gate house that now stands in the middle of Tenth Avenue, an obstruction to travel and an eyesore.

There is not much more to be said. The water leaving the tunnel in one big round column is split by the gate house into eight small streams and sent on its way to Central Park through eight pipes, lying side by side a few feet beneath the surface of the ground. Each pipe has a flowing capacity of 31,250,000 gallons a day. At One Hundred and Twenty-fifth Street, that on the easternmost side leaves the main line, carrying its 31,250,000 gallons in the direction of East River, to supply that part of Harlem. At Manhattan Avenue the second pipe switches off to the southeast. At One Hundred and Tenth Street the pipe on the west is side-tracked, distributing its supply over the hill in the direction of Bloomingdale Asylum and Claremont. At One Hundredth Street, the second pipe on the west breaks away from the line, carrying water to all that region lying between the Park and Riverside Drive.

These desertions leave only four pipes to go to the Central Park distributing reservoirs. Thus we have a vast reduction in the volume of water between the beginning and the end of the aqueduct. The stream begins its journey at Croton Lake, flowing at the rate of 318,000,000 gallons a day. At Jerome Park 68,000,000 are drawn off, at One Hundred and Twenty-fifth Street 31,250 000 gallons, at Manhattan Avenue 31,250,000, at One Hundred and Tenth Street 31,250,000, and at One Hundredth Street 31,250,000. This leaves only 125,000,000 gallons a day for the reservoirs.

The pipes were not in a condition to be journeyed through, so the reporter contented himself with journeying over them and going into manholes here and there to explore gates and valves. The way to go through a four foot pipe is to ride. The engineers use a little velocipede, driven by hand levers, on which they make excellent time.

NO OTHER TUNNEL CAN COMPARE WITH IT.

In all the world no work of a similar character approaches the new aqueduct in magnitude. The Hoosac Tunnel is only five miles long, the Mont Cenis is eight miles, and the St. Gothard nine and a half. The aqueduct tunnel is nearly thirty miles long. At one time as many as 10,000 men were employed on the work. The number of deaths from accident has been small, not exceeding ninety. Several hundred men, since leaving the work, have died of maladies which were probably superinduced by exposure to draughts in going in and out of the tunnel and the breathing of bad air in the headings.

There will be a multitude of claims to settle, but General Duane, as Chief of Engineers in the United States Army, has been fighting claims all his life, and through him the city is bound to be protected. The contractors will sue for the $2,000,000 which it has cost them to repair their fraudulent work, but the evidence against them is colossal and irrefragable. One of them is said to have remarked, on reading the first two installments of the reporter's account of his tour:

"I don't believe that fellow ever went into the tunnel at all. It's all rot. He's just been over here to the commissioners' offices and let them engineers fill him full of guff."

It was one of the disappointments of the journey that the reporter did not have the satisfaction of meeting this contractor. He would have enjoyed a chat with him in one of those cool, dark chambers over the arch, where he sold air to the city at $5 a cubic yard.

A PLOT.

Concerning these frauds, B. S. Church, formerly chief engineer of the new aqueduct, has written to *The Century* as follows:

"No extensive masonry structure was ever built that escaped scamped work, least of all lining masonry built in tunnels, where conditions are so propitious for scamping. Shortly after the masonry work began, I personally discovered the first bad backing masonry at shaft 9. It had been slipped in by an adroit workman and had escaped the notice of a competent inspector in charge. Strict vigilance was demanded on the part of the assistants and inspectors, and orders given that bad masonry, wherever discovered, should be pulled down and properly rebuilt. This was enforced from the beginning of the work. After a time, so frequently did it occur, that I detailed my deputy to devote himself exclusively to its detection and prevention, and later on obtained from the commission authority to organize a systematic investigation of the workmen's methods of concealing slighted work. These clews were followed up by breaking holes in the completed masonry. Special means were devised to detect imperfections, and the matter thoroughly systematized. All this was done months before public attention was drawn to it.

"Then, at my request, the former commission forced contractors to make special agreement in addition to the original contract to repair at their own expense all defective work found. I instituted a special system of repairing bad backing without destroying good brick-work facing it. These methods are used to this day to secure the integrity of the work. All of this, as previously stated, was long before the senate investigating committee convened which resulted in the "change of administration" referred to in your article. So soon as these systematic methods of hiding bad work were unearthed, the former commission indorsed my order that payments should be withheld to cover all that was even suspected of not being up to contract. Thus the city's interests were protected and $1,000,000 withheld to cover costs of repairs.

"Shortly after it was understood that there was no chance to escape detection, and that the bad work was to be repaired at the expense of the contractors, I was interviewed by one of them, and told that if I did not 'let up,' as he expressed it, 'they would have a senate investigation that would break me up.' Of course this threat did not alter my action, and in due course it was executed. I believe some good men have been honestly misled, but that the plot existed and will cost the city dear there can be no question."

WHERE THE PLANS ARE MADE.

One of the most interesting features of the aqueduct construction is the draughting bureau in the Stewart building. F. S. Cook, the engineer in charge, has gathered about him a force of skilled draughtsmen, whose work is of the most exquisite description. Here all Mr. Fteley's designs were worked out. The reporter was treated to a view of his first sketch of the great gate house at Croton Lake, a few crooked pencil marks on a rough piece of paper—a memorandum. The second sketch was more complete, showing the progress of the design in Mr Fteley's mind. The third conveyed his ideas to the draughtsmen, and they built from it the plans of a very handsome structure. On second thought Mr. Fteley, with ever an eye to the city's welfare, decided that a less costly structure would answer every purpose. So the plans were altered. The drawing of the gate house plans alone, some sixty-four in number, represent over 500 days' work for one artist. The drawings required on the entire aqueduct, showing every phase of the work, were over 5,000 in number.

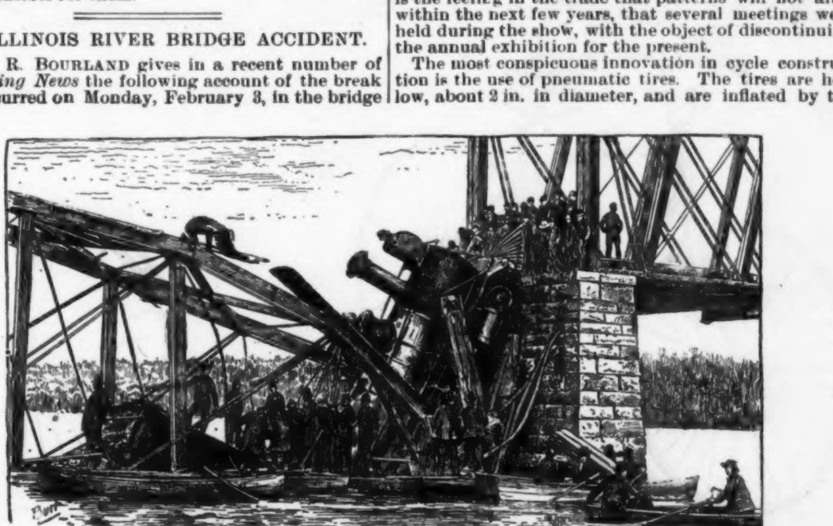
Two days after the completion of his tour the reporter visited Sodom Dam in company of Mr. Fteley, Mr. Rice, and Mr. Burbank, the division engineer in charge. The work is advancing rapidly, and the reservoir will probably be completed before November. The masonry dam, 500 feet long and 78 feet high, is a superb piece of stonework. Here 9,000,000,000 gallons of Croton water will be stored, to be drawn off when needed by the city. This is the first of the great storage reservoirs in the new system. The second is reservoir "M," on Titicus River, the contracts for which will be let in a few days. The Quaker Bridge reservoir is a distant possibility.

S. F. Morris, formerly a division engineer on the aqueduct, writes to the *Tribune* to say that not one foot of the work on his division was ever reported in any way as being ready for acceptance by the city. "Furthermore," he adds, "one-half of this work was built while I was engaged on another portion of the line, and I had nothing whatever to do with it."

It was on Mr. Morris' division, now Mr. Craven's section No. 9, that the reporter visited the costly air chambers over the lining of the tunnel. It has never been charged, however, that Mr. Morris was in any way responsible for them.

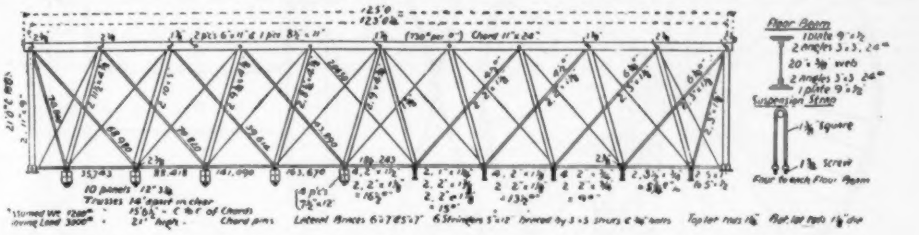
THE ILLINOIS RIVER BRIDGE ACCIDENT.

MR. R. R. BOURLAND gives in a recent number of *Engineering News* the following account of the break which occurred on Monday, February 3, in the bridge crossing the Illinois River at the lower end of Peoria, Ill., called the Peoria and Pekin Union Bridge, it being owned and operated by that company, and used as an entrance to Peoria by the Ohio, Indiana, and Western, the Peoria, Decatur, and Evansville, the Jacksonville Southeastern, and the Lake Erie and Western railroads.



WRECK OF ILLINOIS RIVER BRIDGE.

The bridge went down at about 6.30 P. M., just as a heavy consolidation engine of the O., I., and W. was passing on to the second span. The engine was an eight drive wheel, 86 ton (with tank and load) consolidated, and was pulling a train of thirty cars loaded mostly with grain. The train was moving very slowly. The bridge went down perfectly straight, leaving the track "in line." The tender and cars did not leave the track, and the bridge was not collapsed in the middle by the weight or shock, nor did the other end leave the abutment (as is shown in the general photograph). The span was 125 ft. long, a combination diagonal post structure rebuilt in 1881 by Rust & Coolidge, of Chicago. I send by permission of the railroad a blue print of the dimensions and positions of members as in original contract, and upon examination they are found to be as large or larger in the structure itself. These members were critically examined January 1, 1890, by F. E. McMath, of Detroit Bridge and Iron Works, and pronounced in good condition at that time.



PEORIA AND PEKIN UNION RAILWAY—SIDE ELEVATION OF TRUSS WHICH WAS WRECKED.

No satisfactory cause of failure of the span has yet been discovered. The only break in the iron is found in the eye of rod from the end post on the right side to the foot of first diagonal post. It was the eye in the top chord and shows a flaw. This does not seem sufficient for failure of the span, without some breakage of timber occurring before the bridge fell, and it is impossible to find any breaks in the timber which certainly occurred until caused by crushing against the pier. The only break in masonry is in the coping on left side, in line with the truss. On that side the coping projected much more than on the right side, and appears to be caused by the contact of the top chord as it fell, and not to have caused the fall.

I observed for Mr. Chas. Hansel, by direction of the Illinois Board of R.R. and W. Commissioners, tests of the remaining five spans of the P. and P. U. Bridge on February 10, and found under a load of 2,680 lb. per lineal foot, moving load, deflections as follows (I report center panel deflections only):

Second span....	150 ft.	camber,	0·32 in.	def.	0·12 in.
W. end draw...	150 "	"	0·00 "	"	0·09 "
E. end draw....	150 "	"	0·00 "	"	0·10 "
Fourth span...	150 "	"	0·35 "	"	0·14 "
Fifth span... .	150 "	"	0·38 "	"	0·15 "
Sixth span.. ..	150 "	"	0·30 "	"	0·17 "

After running three engines together (weight 402,000 lb.) back at six miles per hour, readings taken at once showed full recovery to normal position.

THE STANLEY EXHIBITION OF CYCLES, 1890.

THE thirteenth annual exhibition of cycles was held at the Crystal Palace, Sydenham, February 1, 1890, and so large was the number of exhibits that the spacious nave provided insufficient floor room, necessitating the use of the concert room and several of the courts. Upward of 200 firms exhibited, and the number of cycles staged was over 1,500.

Owing to the ever-increasing popularity of the rear-driving safety bicycle, it would be safe to put down at least 85 per cent. of the exhibits to this type of cycle. The novelties and "fads" exhibited showed a marked decrease on previous years, and the trade seems now in a fair way to settle down to fixed patterns. So strong is the feeling in the trade that patterns will not alter within the next few years, that several meetings were held during the show, with the object of discontinuing the annual exhibition for the present.

The most conspicuous innovation in cycle construction is the use of pneumatic tires. The tires are hollow, about 2 in. in diameter, and are inflated by the use of a small air pump. They are said to afford most luxurious riding, the roughest macadam and cobbles being reduced to the smoothest asphalt.

Not having had the opportunity of testing these tires, we are unable to speak of them from practical experience; but looking at them from a theoretical point of view, we opine that considerable difficulty will be experienced in keeping the tires thoroughly inflated.

Air under pressure is a troublesome thing to deal with. From the reports of those who have used these tires, it seems that they are prone to slip on muddy roads. If this is so, we fear their use on rear-driving safeties—which are all more or less addicted to side slipping—is out of the question, as any improvement in this line should be to prevent side slip, and not to increase it. Apart from these defects, the appearance of the tires destroys the symmetry and graceful appearance of a cycle, and this alone is, we think, sufficient to prevent their coming into general use.

From tires we turn to wheels, and this affords an opportunity of dealing with one of the really useful inventions in the exhibition.

We refer to the triangulated wheel, exhibited by the Pilot Cycle Company, of Maidenhead. We illustrate this wheel by Fig. 1.

It will be seen that the spokes are twisted where they cross, each spoke being brought back to the same side of the joint from which it started, instead of continuing to the opposite side, as is the case in all other tangent wheels.

Each spoke therefore joins with its fellow two triangles, the opposite sides of which consist of the wire; the consequence of which is that the tightening of any one wire also tightens the spoke forming the other two sides of the triangle thus the two spokes mutually support each other and divide the work between them. This wheel appears to have all the radial rigidity of a tangent wheel, with the vertical elasticity of a direct spoke wheel.

Another novelty relating to wheels is the Mobilis Radius wheel exhibited by Messrs. Reinhold & Co. We give a section of the hub of this wheel in Fig. 2, from which it will be seen that the spokes are attached to the flanges of the hub, *a*, by means of nipples, *i*, having spherical heads, the object being to relieve the spokes of the great torsion they are subjected to when going over hilly and rough roads. We believe this principle of construction has been tried before, but found wanting in actual practice.

In ordinary bicycles no radical changes have been made. For road work the size of the trailing wheel has been increased and the position of the saddle placed further back, thus giving the machine increased stability. The steering head or joint is now almost universally of the socket type, with ball bearings.

We illustrate a machine of this type by Fig. 3, which shows a Premier Rational ordinary, manufactured by Messrs. Hillman, Herbert & Cooper.

Only one other ordinary bicycle calls for attention, and that is one exhibited by Mr. Edwards, of Rhydwen. It has a lever-driving action with a rolling fulcrum, and seems to be all that can be desired in the way of a lever action. This machine is illustrated by Fig. 4.

In the frames of rear-driving safety bicycles, the diamond or quadrilateral frame is evidently the most popular; though there is apparently a division of opinion as to the best construction of this type of frame.

Some manufacturers make the members of the frame single and some double, some stay the frame by straight stays, as illustrated by Fig. 5, others make the stays curved, as illustrated by Figs. 6 and 7—the former being the Referee, manufactured by Messrs. Morris, Wilson & Co., and the latter the Mohawk, manufactured by Messrs. Thomson & James.

The frames of these two machines have become exceedingly popular, as, while possessing the necessary strength, they have not the rigidity of the straight-stayed diamond frame. A novelty in the construction of frames was shown by Mr. Cocks, of Brentford. We illustrate this by Fig. 8, as we consider it to be one of the best frames in the show. It will be seen that it is of the duplex type, and that each side of the frame consists of one length of tube, thereby avoiding the use of heavy joint pieces. Mr. Cocks' machines are also fitted with an antivibration head of a novel type. The socket of the head is fitted with a row of balls at each end; these balls do not run in the usual radial grooves,

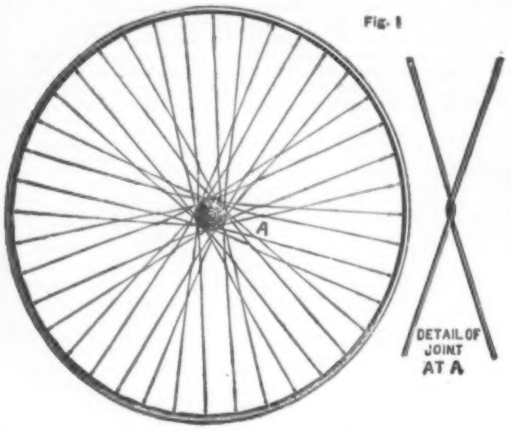


Fig. 1

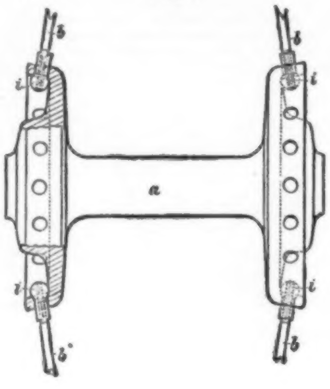


Fig. 2


Fig. 3


Fig. 4

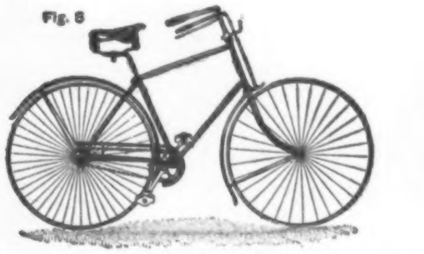


Fig. 5

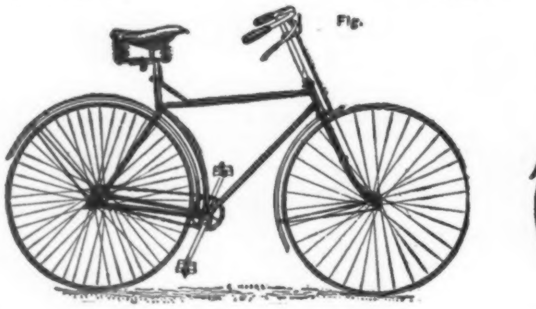


Fig. 6

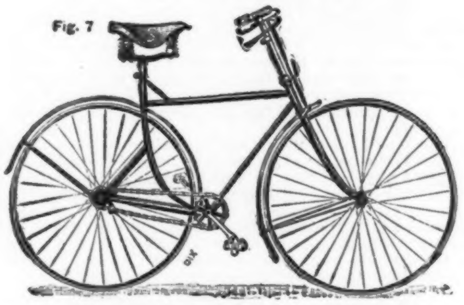


Fig. 7


Fig. 8


Fig. 9

THE STANLEY EXHIBITION OF CYCLES, 1890.

but in axial grooves cut longitudinally in the steering post at equidistance from each other, so that the head is free to turn on and move vertically with respect to the steering post on the same ball bearings, and the whole is so arranged that the wear in all directions is adjusted by one cap.

We believe this to be an entirely new construction of bearing, and we understand that the inventor has had many inquiries with respect to its application to other purposes.

Messrs. Guest & Barrow, the makers of the British Star spring frame bicycle, exhibit a safety, the frame of which is entirely constructed of lengths of rim steel bolted together, no parts being brazed. Owing to the diagonal brace and additional prong to the lower back fork, the frame is immensely strong and cheap withal, as all setting and cleaning of the frame after brazing is avoided.

Messrs. Humber & Co., whose exhibits are, as usual, conspicuous by their splendid finish, show an improved type of their self-steering safety, which is illustrated by Fig. 9. It is claimed for this machine that it can be ridden with ease and safety without the use of the hands. If this is so, it is destined to produce a revolution in the construction of this type of bicycle, as it is this inability to steer without the use of the hands that places this type of machine at a disadvantage as compared with the ordinary bicycle.

Messrs. Ellis & Co. show a machine for which they claim equal facility of steering. It will be seen from Fig. 10, which illustrates this machine, that the steering head is placed at an angle very similar to that on Humber's self-steerer; but the handles are brought back to a convenient position for the rider in a novel manner. The prongs of the front fork are extended upward, outward, and rearward, and carry at their extremities suitably shaped handles. The usual transverse handle bar and steering post is therefore dispensed with.

From the number of safeties adapted for the use of ladies, it seems as if bicycling was becoming popular with the weaker sex, and we are not surprised at it, considering the saving of power derived from the use of a machine having only one slack.

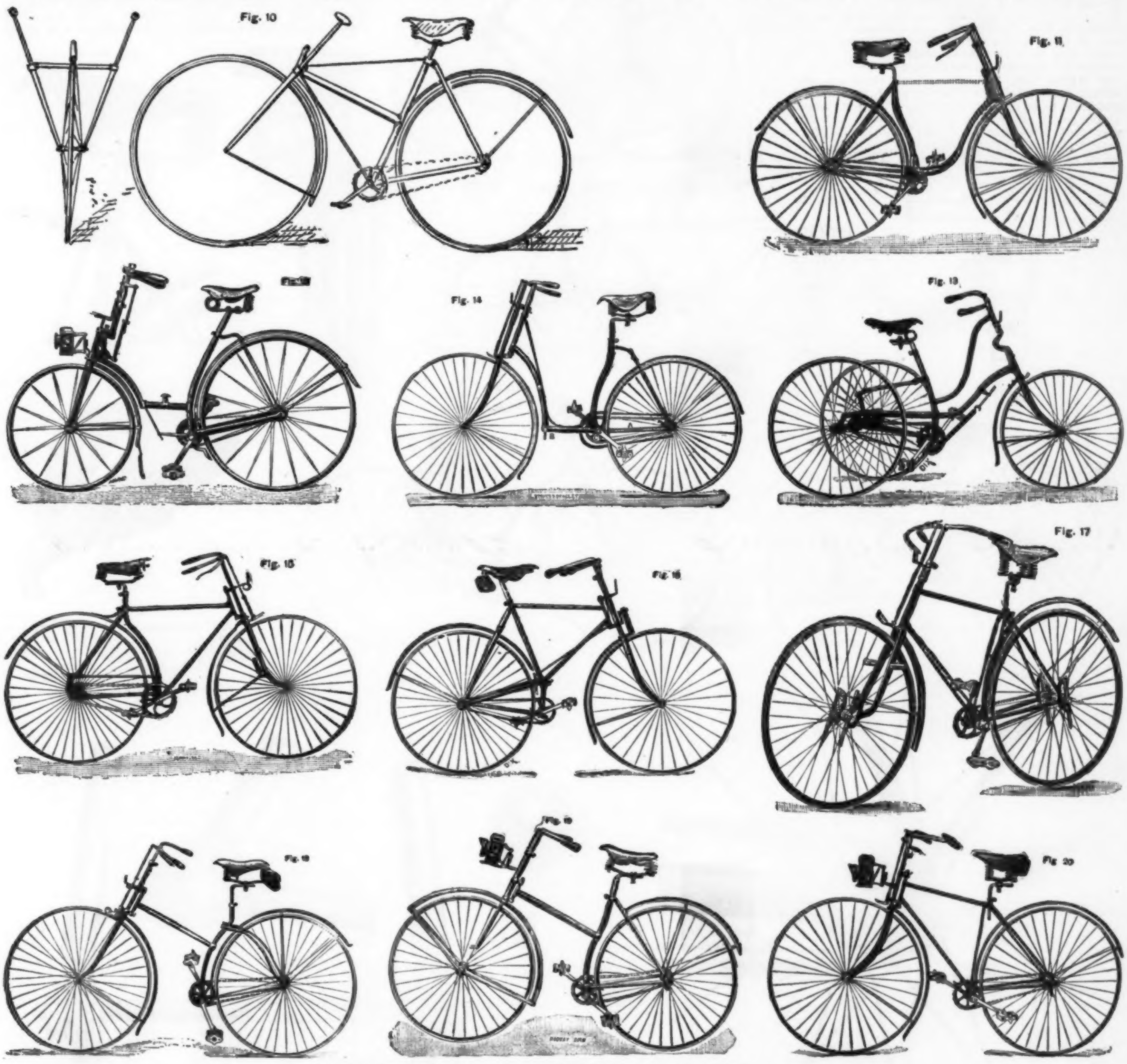
One of the best machines exhibited for the use of ladies is that manufactured by the Success Cycle Company, and illustrated by Fig. 11. By the use of a detachable stay—shown in dotted lines—the machine may be made rigid when used by men.

Mr. Lovelace, of Henstridge, showed a rear-driving safety bicycle, specially adapted for the use of ladies, which he calls the Little Wonder. This machine is illustrated by Fig. 12. It will be seen that it possesses many novel features, the most useful of which are the steering lock and the spring luggage carrier mounted immediately over the front fork. As we predicted last year, the particular construction of the rear-driving safety bicycle demands the use of some device for the suppression of vibration, and there is hardly a maker of this type of machine who has not provided in some way or another to overcome this defect. The Whippet, manufactured by Messrs. Linley & Biggs, still retains its supremacy as the anti-vibration machine *par excellence*, and the firm have this year carried out the same principle in a direct front-steering tricycle, which we illustrate by Fig. 13. It is an essential feature in a spring frame cycle that the relative positions of the seat, pedal crank axle, and handle bar do not move. After the Whippet, we think that a new machine, manufactured by the Midland Cycle Company, called the Sublime, is fairly entitled to a premier position. From Fig. 14, which illustrates this machine, it will be seen that it is adapted for the use of women as well as men, a feature very few spring frame cycles possess. The main frame of this machine is divided in two parts, one carrying the seat, pedal crank axle, and steering head and handle bar, and the other carrying the driving wheel. This latter part, A, is fulcrated to the other part at the pedal crank axle, and an extension, B, runs forward and acts on a spring contained in the curved backbone. The front fork is connected to the steering post by means of a shackle and socket, and its motion is controlled by a spring as illustrated. The Coventry Machinist Company also shows a safety with a spring frame in which the seat, pedal crank axle, and handle bar have no movement with respect to each other. The action of this frame will be apparent on referring to Fig. 15, which illustrates the machine. The Fleetwing Cycle Company exhibits the machine illustrated by Fig. 16, which attains the same end in another manner.

A foreign firm, Messrs. Samuels & Co., of Amsterdam, show a very neat anti-vibration safety which they term the "Buckjumper." It will be seen from Fig. 17, which illustrates this machine, that springs are applied at once to the source of vibration, viz., the point of connections of the wheels with the frame. This has the merit of retaining all the original rigidity of the frame, and it seems to answer its purpose in a very effective manner. This, by the way, is the first time a firm of foreign manufacturers has exhibited at this annual exhibition, and Holland is certainly the last country in the world from which we expected competition. The machines, however, exhibited by Messrs. Samuels & Co. are so well designed and finished that competition from this quarter must not be underrated, more especially when it is considered that these manufacturers are, in their own country, unfettered with patent monopolies and have the advantage of cheap labor.

Messrs. Cooper Kitchen & Co. exhibited a novel form of spring frame in which the members are made of spring steel, thereby avoiding the use of any joints or hinges. We think this a decidedly good thing. Mr. Cousens also exhibited a safety with a frame constructed of spring steel, the whole frame being so designed to give the desired elasticity without the use of controlling springs. Mr. J. Marston showed the machine illustrated by Fig. 18, in which the wheels are allowed an elastic movement while retaining the rigidity of the main frame.

Many other firms exhibited machines with spring forks or devices attached to the steering wheel, but only two call for any special mention: First, that illustrated by Fig. 19, manufactured by Ashton, James & Co., in which the steering wheel is carried in a double fork running fore and aft, and supported by a curved tube running over the top of the wheel, which arrangement seems to answer the purpose well; but in the face of the arrangement shown by Dearlove three years ago it cannot be said to be entirely novel; and secondly, the "Juno" safety, by the Metropolitan



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Machinists Co., and illustrated by Fig. 20. In this machine the extension of the fork carrying the steering wheel works loosely in the steering post against a spring, and unity of action is maintained by means of shackle links connecting the crown of the fork with the base of the steering post.

Messrs. Rudge & Co., among other makers, are fitting to their cycles an anti-vibration handle bar, which has the merit of extreme simplicity. The bar is mounted loose in its socket, and carries a tongue operating on a spring contained in the steering post, and capable of adjustment by a screw in the base of the said post. The handles are therefore free to move downward against the spring, but are rigid against an upward pull. Messrs. Tibly & Marks attain the same end in the manner illustrated by Fig. 21; the steering post, A, carrying the transverse handle bar, is mounted loosely in the socket, B, and is controlled by springs, E, acting between two arms or plates, C and D, carried by the steering post and socket respectively. Messrs. Humber & Co still use their well known and effective spring fork, and give the rider increased cushioning on the rear part by means of a spring seat pillar, as illustrated by Fig. 22, which is an adaptation of the principle of their spring fork. The Quadrant Cycle Company also give increased cushioning at the seat by means of the novel spring illustrated by Fig. 23. Without trying this, we are inclined to think that this spring must pitch the rider forward, as its action does not seem to be directly vertical; with machines having sloping seat pillar supports this defect may not be so apparent. Nothing novel was exhibited in the way of tandem bicycles; the "Lightning" pattern, as described by us in the report of previous exhibitions, has been

Machinists Company exhibited the most radical novelty in tricycle construction, which they call a swing frame tricycle. On reference to Fig. 27, which illustrates this machine, it will be seen that that part of the frame carrying the seat and the steering head and handle bar is fulcrated to the part carrying the driving wheels and pedal crank axle so that it can rock sideways. It will, therefore, be apparent that the rider would have to balance himself as on a bicycle, and the objects appear to be to avoid the objectionable side oscillation caused by the two driving wheels when passing over rough ground, and to allow the rider to readily bring his center of gravity inward when the machine is running on a curve. From a short trial of this machine in one of the corridors, we think there is something in it,

driving chain, and many and various are the dodges for effecting this. When it is considered that the average rider of a cycle is not a mechanic, and that it is more easy to get the chain wheels out of line than to retain them in line during adjustment, it will be seen that there is plenty of scope for the inventor. The device illustrated by Fig. 28 is that used by the St. George's Engineering Company, and is a great improvement on the method usually adopted. The axle of the driving wheel is encircled by a washer, which has a threaded fang which passes through a hole or slot in the rear of the slotted end of the main fork. The position of the axle is adjusted by means of the nut, B, and when the desired adjustment is obtained, the axle is locked to the frame by the nut, A. Messrs. Buckingham & Adams also showed a very ingenious device for this purpose, which is illustrated by Fig. 29. It consists in mounting on the ends of the axle of the driving wheel small eccentric disks, which are adapted to bear against pins or studs on the frame, and so force the axle rearward, when it is turned for the purpose of adjusting the driving chain. Several two-speed gears were exhibited, but beyond being different in the details of construction, they possessed no advantages over gears

Fig. 25

Fig. 22

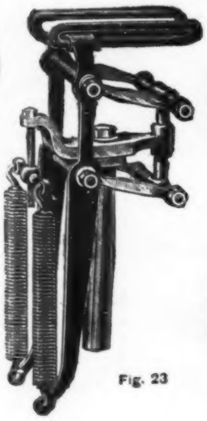


Fig. 23

Fig. 21

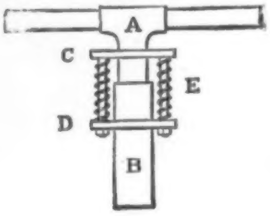


Fig. 24

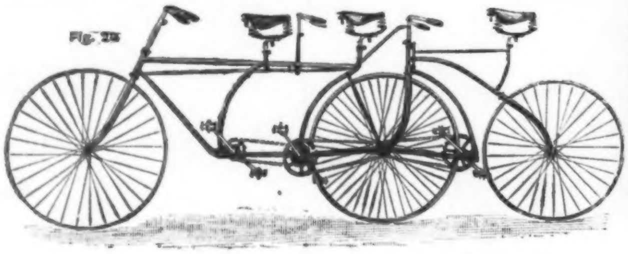


Fig. 26

Fig. 27

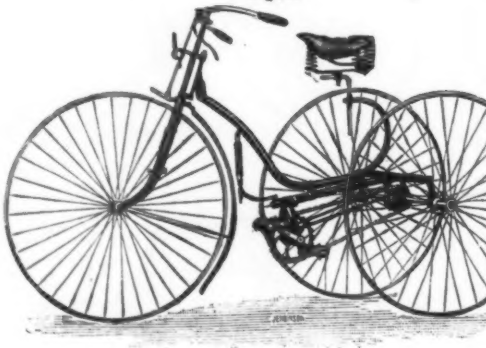


Fig. 30

Fig. 31

Fig. 28

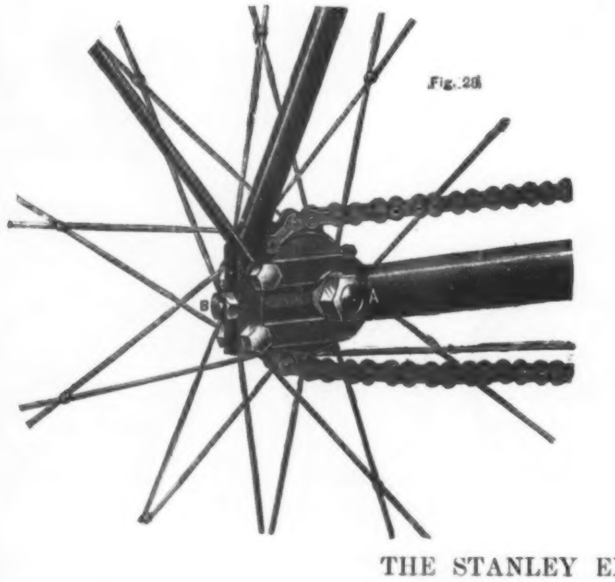
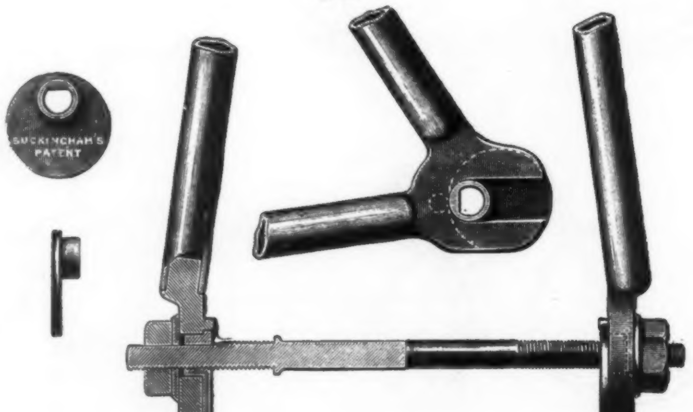


Fig. 29



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universally adopted by the trade. Messrs. Pullinger & Co. show a modification of this machine adapted for three riders, which we illustrate by Fig. 24.

In tricycles little novelty is to be seen. The Fleetwing Cycle Company show a machine which is illustrated by Fig. 25. In this machine, the part of the main frame carrying the driving wheels and pedal crank axle is not rigid with the remaining part of the frame, but is so connected with it that the side tipping due to the driving wheels passing over obstacles is not imparted to the saddle, so that the position of the rider is not disturbed by such influences.

The type of tricycle with a single rear driving wheel and a pair of front steering wheels with a differential steering device still retains its popularity, and the Crypto Cycle Company had on view a perfect gem of this type, weighing but 37 lb. all complete. The Howe Cycle Company show, for the first time, a machine of this type, having a novel form of differential steering. We illustrate this machine by Fig. 26. The Coventry

and we await with interest an extended trial on the road, as, if it proves as successful in actual practice as our short trial warrants us thinking, it will produce a veritable revolution in tricycle construction.

In cycles for military purposes no very great change has been wrought during the year. The absence of multicycles for this purpose justifies the supposition that practice has proved that it is unadvisable to mount more than—at the most—two men on one machine. Messrs. Hillman, Herbert & Cooper had on view fac-similes of machines built for the cyclist corps of the royal marines, which seem to leave only one thing to be desired, and that is the carrying of the rifle in a central position on the machine. The Civil and Military Cycle Supply Association show machines fitted with Watkin's patent stand gear and central supports for the rifle.

Turning to details of construction, one point that requires to be particularly efficient in rear-driving bicycles is the device for adjusting the tension of the

already placed on the market. In cranks a decided novelty was to be seen on the stands of many of the leading makers. The new crank, which is the invention of Mr. F. Southard, of Southampton, is much lighter in weight and smaller in section than the existing types of cranks, and is, moreover, said to be considerably stronger. A Southard crank weighing 7 oz. bears a twisting strain on the pedal of 340 lb. without setting, while the ordinary crank, weighing 16 oz., will only bear a twisting strain of 260 lb. This increased strength is obtained by twisting the cold stampings or forging through an angle of about 180°. The fiber or grain of the metal is thus twisted in one direction, and each of a pair of cranks is twisted in an opposite direction to the other, so that the cranks are right and left handed, and are so fixed to the pedal crank axle that the strain on them is in the direction of the twist, as it is obvious that in the other direction they would be exceedingly weak. We are having a pair of these cranks fitted to one of our mounts, with a view to practically

testing this new innovation. One manufacturer had on view a compound tire of steel and rubber, the rubber being apparently a tire of the usual type fixed in an ordinary rim, but having on its exterior face a steel tire of a crescent section. This is not altogether a new idea, and we do not anticipate that it offers material advantages over the plain rubber tire.

In fittings several ingenious novelties were exhibited. On the stand of Messrs. Linley & Biggs was Mr. Chater Lea's chain guard, which consists of a flanged rubber band made to fit over the driving chain and travel round with it. This appears to be a good thing so long as it can be kept free from oil, the lubrication of the chain being effected with plumbago or other dry lubricant. As to its wear, we cannot speak without a trial; but, as it revolves with the chain, its life seems to depend solely upon the life of the rubber. Pattisson's bifurcated saddle was shown by Messrs. Folly & Webb, and from the illustration of it given by Fig. 30, it now seems to have reached a practical state. It is undoubtedly the only saddle yet designed that thoroughly avoids all pressure on the perineum. The West London Cycle Stores have recently introduced what they claim to be the lightest combined saddle and spring on the market. From Fig. 31, which illustrates this, it will be seen that the front part of the leather seat is mounted on an arm, which acts on a spring contained in the tubular underframe of the saddle. The Holophote Lamp Company showed a decided improvement in lamps; among its other good features, it had a parabolic reflector combined with a bull's eye lens, which increased the light immensely—in fact, we have never seen a cycle lamp which gives even half so intense a light.

The Signal Cyclometer Company showed a new type of cyclometer with shifting figures instead of rotating indices; the audible signal at the completion of each mile, a feature which has made this instrument so popular, is of course retained. Mr. T. M. Hall exhibited what we believe will prove to be a really practical water cycle, if a boat propelled by leg power can be so designated. Mr. Hall seems to have gone into the matter thoroughly, and as a result has produced what is at all events far and away in front of anything of the sort yet produced, if it does not actually reach perfection. It is difficult to form an opinion of a thing such as this without an actual trial, and we await with interest the opportunity to give it a practical trial. Mr. Hall goes in for a boat of narrow beam, and gives the necessary stability by adjustable side floats. The boat is propelled by means of paddle wheels with feathering floats of a novel type, the wheels being actuated by rotary pedals by one or two riders, and the steering is effected through the medium of a transverse handle *a la* bicycle. We are indebted to the *London Engineer* for the foregoing particulars and illustrations.

A SIMPLE METHOD OF DRAWING.

SOME weeks ago we received the prospectus of a new publication formed of small paper books, entitled "Interpretations pour dessiner simplement," by M. Victor Jacquot, of Remiremont (Vosges). A few specimens of the drawings published in this prospectus attracted our attention, and appeared to us to combine much simplicity in the lines with much art in the result obtained. We wrote to Mr. Jacquot for information in regard to his series of books, and he sent us a set. We have examined them, and we are obliged to say that these little books appear to us to constitute a very remarkable work, which will both amuse the pupil and greatly aid him in his task. It is an elegant, artistic method that has pleased all the artists to whom we have shown it, and that we hasten to make known, being persuaded that we shall thereby be useful to more than one of our readers, large and small.

Mr. Jacquot's interpretations show the child who has never drawn a line how he must proceed to succeed at once in drawing. To this effect the author has got up a graduated series of simple lines from which he develops the most varied forms by means of a simplification which suppresses the difficulty of execution without even prejudicing the truth of reproduction. The method is distributed through eight books, in which are studied the most diverse objects, taken isolatedly or grouped in series. Two of these books are devoted to the application of the principles of perspective, and the two last interpret landscapes. Each page of models faces a tinted page upon which the outlines of each subject are feebly but exactly reproduced. The child follows these in making them with a black line in a distinctly defined order, and easily reproduces subjects which interest him, thus acquiring a suppleness of the fingers and a memory of forms.

This sort of study needs little explanation, the sight alone making the natural order in which each line should be placed understood, and the child, encouraged by unexpected success, becomes animated with this sort of work and acquires a taste for it; and he soon remembers the principles of the figures that he has reproduced. These figures are composed, as far as possible, of squares, circles, triangles, oblique and vertical lines, etc. These bases of the drawings are presented in their interesting aspect, and the child retains them with pleasure, and is not drawn away from them as he would be by dry notions of nomenclature.

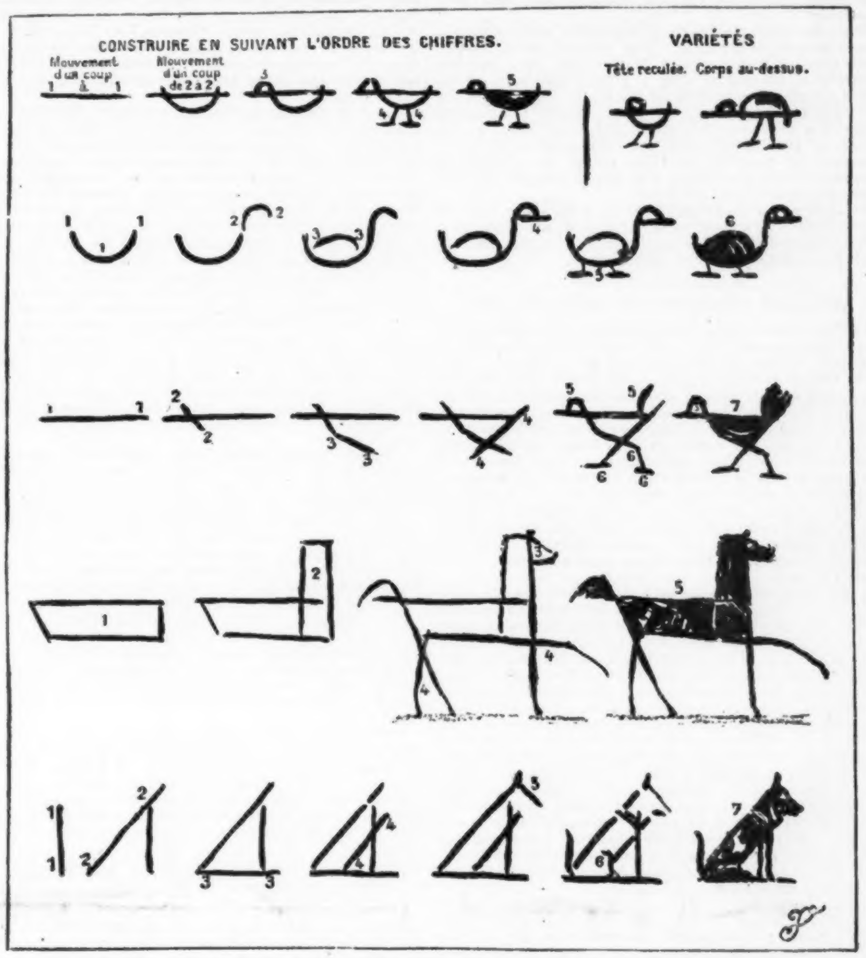


FIG. 1.—JACQUOT'S OUTLINES FOR TEACHING SIMPLE DRAWING.

It often happens that teachers and parents, through not possessing models of the first elements of drawing adapted for early childhood, do not even try to begin this primary education, but await an age that appears to them more opportune, but one in which the suppleness of fingering can no longer be acquired, and in which the A B C of drawing is no longer readily learned.

The new method that Mr. Jacquot presents with confidence to teachers and parents will therefore be profitable to the youngest children. They will thus, without trouble, learn a language which later on they will know how to speak with precision, and they will not have to say, as many do: "Oh, if I only knew how to draw!"

FIG. 2.—LINES FOR DRAWING A PARROT.

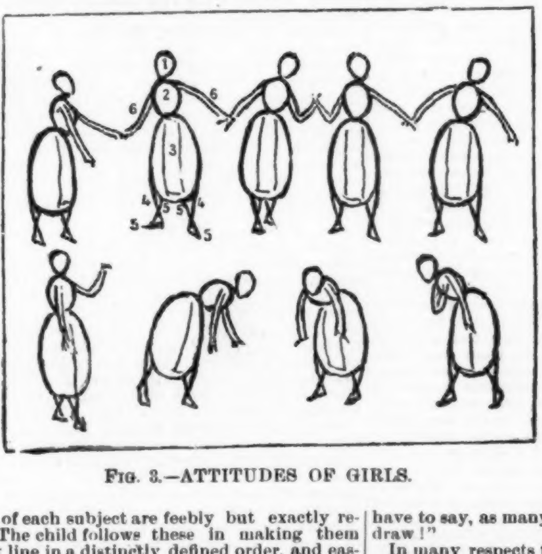


FIG. 3.—ATTITUDES OF GIRLS.

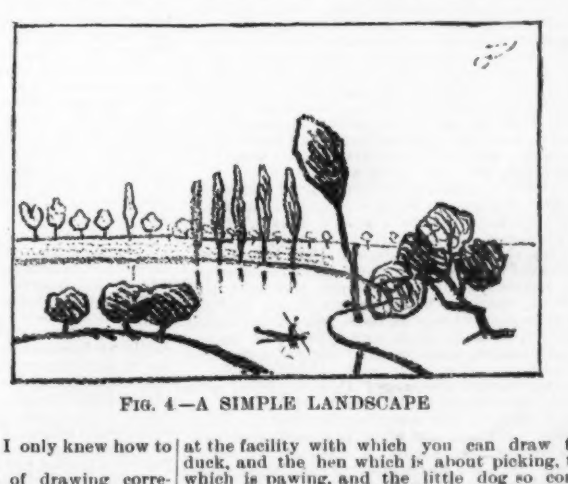


FIG. 4.—A SIMPLE LANDSCAPE

In many respects this language of drawing corresponds to spoken language. The one makes use of letters that it assembles in words, and then in phrases, in order to become the expression of thought. The other assembles its lines in squares, triangles, circles, etc., mingles these according to established proportions, in order to translate a collection of more or less elevated ideas. These two languages may accord with each other, and render the subject even, with as much art, provided that the study of them has been regular, and that a certain talent, a gift of nature, be awakened by practice and instruction.

It was with such views that the author conceived his interpretations, which he has desired to make a sure as well as pleasing guide to direct the first steps of young draughtsmen.

He gives his method as the fruit of a long period of teaching, and with the certainty of rendering a service to the cause of the art whose fervent disciple he remains. We present herewith a few drawings from Mr. Jacquot's method.

Fig. 1 gives specimens from the first book. Follow the lines indicated, and you will be greatly surprised at the facility with which you can draw the little duck, and the hen which is about picking, the horse which is pawing, and the little dog so composedly seated. Mr. Jacquot thus obtains all the attitudes of motion of various animals. There is not a page of his albums that is not a delightful surprise to the eyes.

Further along, in the third book, we have butter-

flies, parrots (Fig. 2), pea fowls, elephants, camels, and pelicans.

With the fourth book we come to the attitudes of man, which are obtained with squares and ovals. Everything is absolutely simple and ingenious. This may be judged of from Fig. 3, which represents little girls dancing, and others courtesying. Further along, we have drawings of ball players, mountebanks, etc. The books follow one another methodically and progressively.

With the fifth we learn perspective, and with the others landscape drawing. The author excels in this latter kind of drawing, and, with a few lines, renders nature in all its truth. Fig. 4 gives a specimen of one of the simplest landscapes of the book. We gradually pass to more important subjects. There are general views of a very complete effect obtained with a few strokes of the pencil, and we can admire stumped drawings of moonlights that recall the delightful drawings of the Japanese, who are so skillful in well interpreting the external world.

Mr. Jacquot is an artist of talent and taste, and he has devised a new method of teaching drawing that appears to us destined to render great services and to merit the greatest success.—*La Nature.*

WILLIAM GILBERT, OF COLCHESTER.

AT the present time, when the whole civilized world is at last awakened to the value of the application of electricity to the use and convenience of man; when it has almost become a part of his daily life; when it is weighed and measured with far more accuracy than his daily food, and has raised up an entirely new profession and many new industries giving employment to many thousands of workmen, it is interesting to look back to the time when nothing more was known of this great power of nature than the feeble picking up of straws and similar light objects by amber and by tourmaline after friction had been applied to their surfaces, and to compare such times with the last half century, during which such enormous developments of the allied sciences of magnetism and electricity have taken place.

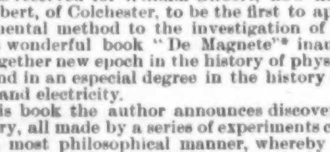
It is a very remarkable fact that from the year 600 B. C., when Thales, the Milesian, first pointed out the attracting influence of rubbed amber, followed, some three hundred years after, by Theophrastus, the Lesbian, who showed that lyncurium or tourmaline possessed similar properties, until the end of Queen Elizabeth's reign, no attempt appears to have been made to investigate this curious phenomenon, although it had been referred to by many writers, as a fact, and such attempts at explanation as were ventured upon were founded on some metaphysical or magical hypothesis, a habit of thought which prevailed during that period.

It was reserved for William Gilbert, now known as Dr. Gilbert, of Colchester, to be the first to apply the experimental method to the investigation of science, and his wonderful book "De Magnete"* inaugurates an altogether new epoch in the history of physical science, and in an especial degree in the history of magnetism and electricity.

In this book the author announces discovery after discovery, all made by a series of experiments conducted in a most philosophical manner, whereby he was enabled to explode most of the absurd theories by which the ancients, and many of his predecessors, had attempted to explain the action of the loadstone and the attractive influence of rubbed amber and tourmaline.

It was William Gilbert who first differentiated between magnetic and electrical phenomena. Electricians and electrical engineers will do well to remember that he must ever be regarded as the first electrician and the father of their profession, for not only was he the first to investigate electrical phenomena, but the very word *electric* was coined by him, and it is to him that we owe the words *electricity* and *electrical.*

By means of a simple form of electroscope, consisting of a light metallic needle balanced on a pivot, figured in his book, which illustration we reproduce herewith, Dr. Gilbert discovered that a large number of



substances possessed, when rubbed, the electrical properties of amber, jet, and tourmaline, and to these substances he gave the name *electrics.* With this simple apparatus he found that the following substances besides amber and jet, when rubbed, attracted the needle: Diamond, sapphire, carbuncle, cat's eye (?) (*iris gemma*), opal, amethyst, vincentina, and bristola (an English gem or spar), beryl, paste such as is used for artificial gems, glass of antimony and rock crystal, also several kinds of slags from mines, belemnites, sulphur, mastic, hard wax, and sealing wax, made of lac and of various colors,† resin and arsenic (but somewhat feebly), rock salt, mica, and rock alum.

All the above substances Gilbert found attracted, with varying degrees of force, not only straws and light fibers, but also all metals, woods, leaves, stones, earths, and even water and oil.

Further on, Gilbert states (page 51) that he was unable to discover this electrical power in emerald, agate, carnelian, pearls, jasper, chalcedony, alabaster, porphyry, coral, marble, black jasper (*lapis Lydius*), flint, hematite, emery (*smyris*), bone, ivory, hard woods, such as ebony, cedar, juniper, and cypress, as well as metallic substances, such as gold, copper, iron, and magnetic ore.

Gilbert, moreover, discovered that electrical phenomena are, to a considerable extent, affected by the humidity of the air; that a dry condition of the atmosphere, with north and east wind, is most favorable to their production, while a moist state of air, with a south wind, offers the worst possible conditions under which to make electrical examinations.

Perhaps the most important discoveries made by Dr. Gilbert were in connection with magnetic phenomena, the greatest of which was that the earth itself is a great magnet, and he thus was enabled to explain the declination and dip of the magnetic needle in a philosophical manner for the first time in the history of magnetism.

This again he arrived at by a series of very interesting experiments, in the course of which he fashioned a piece of magnetic ore or loadstone into a sphere to which he gave the name "terella," or little earth, and by means of suspended magnets he was able to reproduce in miniature all the phenomena described by navigators and other travelers as affecting the mariner's compass.

There is abundant testimony extant that this "De Magnete" of Gilbert's produced a profound sensation, not only in this country, but throughout the then civilized world, and it is a singularly curious fact that the brilliancy of a reputation so great and so original should have been allowed in subsequent generations to have been lost sight of in the more blinding light of more recent knowledge and discoveries, and it is equally remarkable that a book so classical in its nature, so remarkable in its originality and prescience, and which was thought so much of during the periods which immediately followed its publication, should never have been translated into English, or, indeed, into any other language; and this is rendered still more curious by the fact that such a translation was actually called for at the time, and the want of it was considered remarkable as far back as the year 1618; and here it will be interesting to quote from the preface to a scarce old book* published at that date by the Rev. William Barlowe, archdeacon of Salisbury, and a very intimate friend of Dr. Gilbert's.

"Many of our nation," he says, "both gentlemen and others of excellent witts and louers of these knowledges, not able to read Doctor Gilbert's booke in Latin haue bin (euer since the first publishing thereof) exceeding desirous to haue it translated into English, but hitherto no man hath done it, neither (to my knowledge) as yet goeth about any such matter, whereof one principall cause is that there are very few that understande his booke, because they haue not Load-stones of diuers forms but especially round ones," and the author gives a further supposition that "a second cause may be that there are diuers wordes of art in the whole course of his booke proper to his subject, and fitt to the explication of his figures and diagrammes which cannot be understood without the helpe of mathematicks and good trauelling in the magneticall practice."

Archdeacon Barlowe was a great worker at magnetism himself, and his association with Dr. Gilbert is exceptionally interesting from the fact that the only known letter of Gilbert's was written to him; and as it not only sets forth the nature and character of the man, but also shows the appreciation with which "De Magnete" was received on the Continent, we print it in full:

To the Worshipfull my good friend, Mr. William Barlowe, at Easton, by Winchester.

Recommendations with many thanks for all your paines and courtesies, for your diligence and enquiring, and finding diuers good secrets. I pray procede with double-capping your Load-stone you speake of, I shall bee glad to see you, as you write, as any man, I will haue any leisure, if it were a moneth, to conferre with you, you haue shewed mee more—and brought more light than any man hath done. Sir, I will commend you to my L. of Effingham, there is heere a wise learned man, a Secretary of Venice, he came sent by that State, and was honourably receiued by her Majesty, he brought me a lattin letter from a Gentleman of Venice that is very well learned, whose name is Iohnnes Franciscus Sagredus, he is a great magneticall man, and writeth that hee hath conferred with diuers learned men of Venice, and with the Readers of Padua, and reporteth wonderfull liking of my booke, you shall haue a copy of the letter: Sir, I propose to adioyne an appendix of six or eight sheets of paper to my booke after awhile, I am in hand with it of some new inuentions, and I would haue some of your experiments, in your name and inuention, put into it, if you please, that you may be knowen for an augmenter of that art. So for this time in haste I take my leaue the xiiy of February. Your very louing friend,

W. GILBERT.

It is somewhat unfortunate that Gilbert omitted the year from the date of this letter, but it was probably about 1602, and for the following reasons "De Magnete" was published some time during the year 1600, so we can hardly suppose, in such times of slow and difficult traveling, the work could have been studied and commented on by the learned men of Venice and Padua before the following year, and it is also fairly certain that the promised appendix describing new inventions never was written, for Gilbert died in 1603, and although later editions of his book were published in Stettin, and in Frankfort in 1628, 1629, 1633, and 1638, they did not contain the promised addition.

Again, it is fair to assume that the inventions referred to were the nautical instruments described in a curious old book by Gilbert's friend, Thomas Blundeville, published in 1602, of which the following is the quaint and lengthy title:

"The Theoriques of the seuen Planets shewing their diuerse motions, and all other accidents called Passions thereunto belonging. Now more plainely set forth in our mother tongue by *M. Blundeuile,* than euer they haue been heretofore in any other tongue whatsoeuer, and that with such pleasant demonstratiue figures as euery man that hath any skill in Arithmetick, may easily vnderstand the same. A booke most necessarie for all Gentlemen that are desirous to be skilfull in Astronomie, and for all Pilots and Sea men, or any others that loue to serue the Prince on the Sea, or by the Sea to travell into forraine Countries. There is also hereto added, The making, description and vse, of two most ingenious and necessarie Instruments for *Sea men to find out thereby the latitude of any Place upon the Sea or Land, in the darkest night that is without the helpe of Sunne, Moone, or Starre. First inuented by M. Doctor* Gilbert, *a most excellent Philosopher, and one of the Ordinarie Physicians to her Maiestie; and now here plainely set downe in our mother tongue by Master* Blundeuile. London, Printed by Adam Islip, 1602."

It is probable that the addition to "De Magnete" was abandoned by Gilbert on account of his new appointment as principal physician to the queen, and the consequent increased demands upon his time, and he appears to have arranged with his friend to publish the two inventions in the above forthcoming book instead of doing so himself, for after describing the instruments, "Master Blundeuile" says:

"Both these Instruments I receiued not long since from my deare friend M. Doctor *Gilbert,* for the which I most heartely thank him, the inuention of which Instruments deserueth more worthie commendation and praise, than I am able any way to yeeld, hoping that all Sea men will bee as thankefull to him as I am in heart and good will, for whose profit there was neuer inuented from the beginning of the world two such noble and necessarie Instruments as these are, and therefore worthie to be esteemed of all men accordingly."

As we have before pointed out, there were five editions of "De Magnete," the first folio edition being published in London in 1600, three years before the author's death. The next issue was in quarto, published at Stettin in 1628, followed in the following year by a quarto published at Frankfort. The next was a second edition of the Stettin quarto in 1633, and this was followed by another Frankfort copy in 1638.

Gilbert's other work, "De Mundo Nostro Sublunari Philosophia Nova," was published in Amsterdam by his brother forty-eight years after the author's death, from a manuscript which had been preserved in the library of Sir William Boswell.

We have already referred to Dr. Gilbert's researches in magnetism and electricity, and to the subsequent publication of his great work "De Magnete" in 1600. This book had been promised for some years before, and the scientific world throughout Europe expected great things from it, for Gilbert's reputation as a philosopher and original investigator had been established throughout the schools on the Continent for many years. When the book appeared these expectations were more than realized, and there is abundant evidence to show that by it the reputation of Gilbert, and of the country in which he worked, were in the eyes of the whole scientific world raised to a high position.

In connection with this part of our subject it will be interesting to refer to some of the opinions that were expressed by men of learning at the time and shortly after the publication of "De Magnete." We have already referred to Gilbert's own letter to William Barlowe, in which he tells his friend of the appreciation with which his book was received by the learned men of Venice and Padua, undoubtedly referring among these to the great Galileo, who was at that time professor of mathematics in the latter university; and the following is what Barlowe, himself "a great magneticall man," wrote in 1618 of Gilbert's discoveries:

"That wonderfull propertie of the body of the whole earth called the magneticall vertue (most admirably found out and as learnedly demonstrated by Dr. Gilbert, physitian vnto our late renowned soueraigne Queene Elizabeth of happy memory) is the very true fountaine of all magneticall knowledge. So that although certain properties of the Loadstone were knowne before, yet all the reasons of those properties were vtterly vnknowne and never before revealed (as I take it) vnto the sonnes of man."* It is an interesting fact as showing the advancement of Gilbert's mind that he adopted the Copernican doctrine respecting the earth's motion—a view which even the great mind of Francis Bacon failed to grasp. William Barlowe, as an archdeacon of the church, could hardly have been expected to support the view that the earth was the moving body, and not the sun, and he refers to it in a quaint manner, in which, after attesting the general correctness of Gilbert's experimental deductions, he says, "but, concerning his sixth booke entreating of the motion of the earth, I think there is no man liuing farther from beleauing it than my selfe, being nothing at all perswaded therevnto by the reasons of other men. *Amicus Socrates, Amicus Plato sed magis amica veritas* is the onely cause why I doe embrace his iudgment in the one, and refuse it in the other, in matters of this nature following the rule *Nullius addictus iurare in verba magistri.*"

Nathaniel Carpenter, the geographer and mathematician, who wrote in 1625, thus speaks of Gilbert's work:† "Magneticall properties, I find in ancient Writters, as little knowne as their causes; and if any matter herein were broached, it was merely coniectural, and depending on no certain demonstration; neither had we any certain or satisfactory knowledge of the thing vntill such time as it pleased God to raise vp one of our country men *D. Gilbert,* who to his euerlasting praise hath trodden out a new path to *Philosophie,* and on the Loadstone, erected a large *Trophie* to commend him to posterity. This famous Doctor being as pregnant in witty apprehension as diligent in curious search of naturall causes, after many experiments and long inquiry, found the causes of most magneticall motions and properties hid in the magneticall *temper* and constitution of the *Earth,* and that the earth it selfe was a meere *magneticall* body challenging all those properties, and more than haue expressed themselves in the Loadstone; which opinion of his was no sooner broached than it was embraced and wel-commed by many prime wits as well *English* as *Forraine.* Insomuch that it hath of late taken large root and gotten much ground of our *Vulgar Philosophie.*"

The attitude which Francis Bacon assumed toward Gilbert was a curious mixture of praise and depreciation which usually betrays a jealous feeling. It is true that he refers to "De Magnete" as a painfull (*i. e.,* painstaking) experimentall booke,‡ but in many other passages his references to Gilbert and his work have a distinctly sneering tone, while in one place he speaks of his experimental method of investigating scientific

* "De Magnete Magneticisque Corpoibus, et de Magno magnete tellure; Physiologia noua plurimis & argumentes, & experimentis demonstrata." Guelielmi Gilberti; Colcestreusis Medici Londinensis, Londioni, Anno, 1600.

† "De Magnete," p. 48.

* "*Magneticall Advertisements* or diuers pertinent obseruations and approued experiments concerning the natures and properties of the Loadstone. Very pleasant for knowledge, and most needfull for practice of trauelling, or framing of instruments fitt for Travellers both by Sea and Land. London, Printed by Edward Griffin for Timothy Barlow, and are to be sold at his shop in Paul's Church Yard at the signe of *Time.* 1618."

* "Magneticall Aduertisements," London, 1618.

† "Geography Delineated Forth in Two Bookes containing the Sphaericall and Topicall Parts thereof," by Nathaniel Carpenter, Fellow of Exceter Colledge, in Oxford. Oxford, 1625.

‡ "Advancement of Learning."

phenomena and founding theories thereon as something almost childish, and he characterized it as "an instance of extravagant speculation founded on insufficient data."* Again, in another place, he says, "Another error is that men have used to infect their meditations, opinions, and doctrines with some conceits which they have most admired, or some sciences to which they have most applied and given all things else a tincture according to them utterly untrue and unproper. . . . So have the Alchemists made a philosophy out of a few experiments of the furnace, and Gilbert, our countryman, hath made a philosophy out of the observations of a loadstone (philosophiam etiam e magnete elicuit)."†

Such criticism falls somewhat awkwardly from the great author of the "Novum Organum," which, more than any other of his works, has gained for Bacon the credit of being the father of the inductive and experimental method of philosophy which Gilbert had inaugurated a quarter of a century before. In reference to it, Humboldt says: ‡ "Bacon, whose comprehensive views were unfortunately accompanied by very limited mathematical and physical knowledge, even for the age at which he lived, was unjust to Gilbert;" and, in still more recent times, Dr. Whewell has remarked§ that "Bacon showed his inferior aptitude for physical research in rejecting the Copernican doctrine, which William Gilbert adopted."

In an earlier part of this article we referred to the learned men of Venice and Padua as undoubtedly including the great Galileo, and in support of this we will quote the following interesting words written by Galileo Galilei himself: "I extremely admire and envy the author of 'De Magnete.' I think him worthy of the greatest praise for the many new and true observations which he has made, to the disgrace of so many vain and fabling authors; who write not from their own knowledge only, but repeat everything they hear from the foolish and vulgar, without attempting to satisfy themselves of the same by experience; perhaps that they may not diminish the size of their books."‖

In a very curious and celebrated old book by Sir Kenelm Digby, which was published in 1644,¶ the following interesting reference to Gilbert's work and reputation is made in a chapter entitled "Of the Loadstone's Generation and its Particular Motions:" "But to come to experimentall proofes and obseruations vpon the loadstone by which it will appeare that these causes are well esteemed and applyed, we must be beholding to that admirable searcher of the nature of the loadstone, Doctor Gilbert; by means of whom and of Doctor Harvey, our Natiō may claim euen in this latter age as deserued a crowne for solide Philosophicall learning as for many ages together it hath done formerly for acute and subtile Speculations in Diuinity. But before I fall to particulars, I thinke it worth warning my Reader, how this great man arriued to discouer so much of Magneticall Philosophy; that he likewise, if he be desirous to search into nature, may by imitation advance his thoughts and knowledge that way.

"In short, then, all the knowledge he gott of this subject was by forming a little loadstone into the shape of the earth. By which meanes he compassed a wonderfull designe, which was to make the whole globe of the earth maniable; for he found the properties of the whole earth in that little body; which he therefore called a Terrella, or little earth; and which he could manage and trye experiences vpon att his will. And in like manner, any man that hath an ayme to aduance much in naturall sciencies, must endeauour to draw the matter he enquireth of, into some such modell, or some kinde of manageable methode; which he may turne and wind as he pleaseth. And then lett him be sure, if he hath a competent understanding, that he will not misse of his marke."

The learned historian of the Royal Society, Thomson, thus refers to "De Magnete:" "Dr. Gilbert's book on Magnetism, published in 1600, is one of the finest examples of inductive philosophy that has ever been presented to the world. It is the more remarkable because it preceded the *Novum Organum* of Bacon, in which the inductive method of philosophizing was first explained."** In concluding this portion of our subject we will quote from the testimony of the eminent historian Hallam to the debt which this country and science in general owes to the memory of William Gilbert: "The year 1600 was the first in which England produced a remarkable work in physical science; but this was one sufficient to raise a lasting reputation for its author. Gilbert, a physician, in his Latin treatise on the magnet, not only collected all the knowledge which others had possessed on the subject, but became at once the father of experimental philosophy in this island, and, by a singular felicity and acuteness of genius, the founder of theories which have been revived after a lapse of ages, and are almost universally received into the creed of science. Gilbert was one of the earliest Copernicans, at least as to the rotation of the earth, and with his usual sagacity inferred, before the invention of the telescope, that there are a multitude of fixed stars beyond the reach of our vision."††

We have referred at considerable length to the world wide reputation of the author of "De Magnete," and to the high esteem in which his work was held by his contemporaries and by more recent critics, because, as we have before pointed out, the name of Gilbert and the importance of the discoveries he made have been too much passed over by modern writers, but few of whom have read his book, and this for two causes, first, because the book itself is very scarce, having never been reprinted since 1638, and it has never been translated into English or into any modern language. We are happy to say, however, that this reproach upon our scientific patriotism will very soon be removed, and the want which William Barlowe called attention to in 1618 will very soon be met. We are approaching the tercentenary of "De Magnete," and with the object of celebrating the event a Gilbert Club has recently been formed, having for its first president Sir William Thomson, who more than any one else is the representative of the combination of abstract mathematical electricity and magnetism with their applications to the service of man, and who, like Gilbert, has founded theory upon experimental research and has resorted to experiment again to verify theoretical conceptions.

The Gilbert Club held its inaugural meeting a month ago, when the following were adopted by resolution as the objects of the club:

(i) To produce and issue an English translation of "De Magnete" in the style of the folio edition of 1600.

(ii) To arrange hereafter for the tercentenary celebration of the publication of "De Magnete," in the year 1900.

(iii) To promote inquiries into the personal history, life, works, and writings of Dr. Gilbert.

(iv) To have power, after the completion of the English edition of "De Magnete," to undertake the reproduction of other early works on electricity and magnetism, provided at such date a majority of members of the club so desire.

The following gentlemen were elected as the council and officers for the ensuing year:

President: Sir William Thomson, LL.D., F.R.SS.L. and E., president of the Institution of Electrical Engineers.—Vice president: The Right Hon. Lord Rayleigh, Sec. R.S. Jonathan Hutchinson, F.R.S., president of the Royal College of Surgeons. Professor A. W. Reinold, F.R.S., president of the Physical Society. Benjamin Ward Richardson, M.D., F.R.S. Professor David E. Hughes, F.R.S. Henry Laver.—Treasurer: Latimer Clark, F.R.S.—Council: W. Lant Carpenter. Professor John Ferguson, M.A., F.R.S.E. Professor George Forbes, M.A., F.R.SS.L. and E. Professor G. C. Foster, F.R.S. Sir Philip Magnus. Professor A. W. Rücker, F.R.S.—Hon. Secretaries: Conrad W. Cooke; Professor Raphael Meldola, F.R.S.; and Professor Silvanus P. Thomson.

In accordance with the first and principal object of the club, we are glad to state that the translation of "De Magnete" is well in hand, and it will be printed and "got up" in such a manner as to be as like the original in appearance as it can be made; it will, in fact, be a fac-simile reprint in everything except the language in which it is reproduced. In illustration of this we print herewith a reduced fac-simile of a speci-

ON THE MAGNET, BK. III. 139

CHAP. XII.

How polarity exifts in any hardened iron, not excited by a magnet.

HItherto we have declared the natural and innate caufes and the powers acquired by means of the ftone: but now the caufes of magnetic virtues in hardened iron, not excited by the ftone are to be inveftigated. Magnet and iron fhow and difplay to us wonderful fubtilities. It has often been demonftrated before that iron not excited by a ftone is borne north and fouth; but alfo that it has polarity, that is it has the proper and fingular polar diftinctions juft as a magnet or a piece of iron rubbed with a magnet. That which appeared to us at firft wonderful and incredible is: The metal of iron from the lode is heated in the furnace, flows out of the furnace, and hardens in a great mafs, that mafs is divided in great workfhops, and is beaten out into iron rods, from which again the fmiths fafhion very many tools, and needful implements. So the fame mafs is varioufly worked up and tranfformed into many fimilitudes. What then is that which

maintains

men page, which will give a fair idea of the general appearance of the work, but we would point out that the initial letter is only a temporary "dummy" to take the place of the fac-simile of the very charming original which is not yet ready.

The following particulars respecting this eminent man will be of some interest in connection with this article. William Gilbert was the eldest of the five sons of Jerome Gilbert, the Recorder of Colchester, and was born in that town in the year 1540. Some of his biographers state that he was educated both at Oxford and at Cambridge, but of his connection with the former university there appears to be no authentic record. The statement arose probably from the fact that by his will he bequeathed his portrait to the schools gallery at Oxford, showing that he had some special regard for the older university, from which it might reasonably have been assumed (in the absence of evidence to the contrary) that Oxford was his *alma mater*. His record at Cambridge, however, is so clearly established that there is little room for the supposition that the University of Oxford can claim any share in his education. It is far more probable that some honorary distinction was conferred upon him in after life by that university, and that his bequest was a mark of his appreciation of that honor. At the age of eighteen he matriculated at St. John's College, Cambridge, *i. e.*, in May, 1558, taking his B.A. degree in 1560, when he was elected a fellow of his college on Mr. Symson's foundation in his twenty-first year. He took his M.A. degree in 1564, and became mathematical examiner at St. John's in 1565 and 1566. He was senior bursar of his college in 1569, taking his M.D. degree the same year, and a few months after became senior fellow of St. John's.

After leaving the university he traveled for three years on the Continent, returning in 1573, where at the age of thirty-three he was elected a fellow of the College of Physicians, and took up his abode in London, where he practiced as a physician "for more than thirty years with great honor and success."* His house was on St. Peter's hill, near St. Paul's, between Upper Thames street and Little Knight Rider street.† It is possible that this was the house of the College of Physicians. He became one of the physicians in ordinary to Queen Elizabeth, who, it is said, granted him a pension, to enable him to prosecute his scientific researches, and in February, 1600, he was appointed chief physician to the Court. The date of this appointment is fixed by a letter from John Chamberlain (who resided with Gilbert) addressed to Sir Dudley Carleton, afterward Lord Dorchester, and dated February 3, 1600, in which the following passage occurs: 'The Queene hath made choise of our Doctor for her phisition but he is not yet sworne," and this was followed by another letter dated February 24, 1600–1, and addressed "To my very goode frend Mr. Dudley Carleton geve these, at The Haghe or elsewhere," in which Chamberlain tells his friend "The Covie" (*i. e.*, covey) "is now dispersed and we are driven to seeke our feeding further of, our Doctor being alredy setled in Court and I redy to go to Askot."‡

Having been elected, as we have already stated, a fellow of the College of Physicans in 1573, he held the office of censor in the years 1581 and 1582, again from 1584 to 1587, and for a third time in 1589 and 1590. He was treasurer to the College from 1587 to 1591, and again from 1597 to 1599, and he held the office of consilarius from 1597 to 1599, being appointed in the place of Dr. Giffard, and in 1600 he was elected president. The Queen died in March, 1603, and her successor, James I., on his accession, continued Gilbert's appointment as principal court physician, but he held it for only a few months, for he died on November 30 in the same year, in the sixty-third year of his age.

Gilbert had during his residence in London amassed a valuable collection of magnets, globes, minerals, and philosophical instruments, which, together with his library, he bequeathed to the College of Physicians, and it remained in the house of the college at the bottom of Amen Corner until 1666, when it was unhappily totally destroyed in the great fire of London. He left his portrait, as we have before stated, to the University of Oxford.

We cannot conclude this notice of William Gilbert's life and work better than in the quaint words of old Dr. Fuller, who thus refers to him: "He hath the *clearness of Venice Glass* without the *Brittleness* thereof, soon *Ripe* and long *lasting* in his Perfection. He commenced *Doctor* in *Physick*, and was *Physician* to Queen *Elizabeth*, who stamped on him many marks of her favour, besides an annuall Pension to encourage his studies. He addicted himself to *Chemistry*, attaining to great exactness therein. One saith of him that he was *Stoicall*, but not *Cynicall*, which I understand *Reserved*, but not *Morose*, never married, purposely to be more beneficial to his brethren. Such his *Loyalty* to the Queen that, as if unwilling to survive, he died in the same year with her, 1603. His *Stature* was *Tall*, *Complexion Cheerfull*, an Happiness not ordinary in so hard a student and retired a person. He lyeth buried in *Trinity Church* in Colchester under a plain monument.

"*Mahomet's Tombe*, at Mecha, is said strangely to *hang* up, attracted by some invisible *Loadstone*, but the memory of this *Doctor* will never fall to the ground, which his incomparable Book "De Magnete" will *support* to Eternity."§—*Engineering.*

TELEPHONIC SPECIFIC INDUCTIVE CAPACITY.‖

By F. H. SAFFORD and G. U. G. HOLMAN.

IN a paper on the construction of telephone circuits, read before this academy on June 15, 1887, by the electrician of the American Bell Telephone Company, Dr. Jacques, it was pointed out that "the readiness with which telephonic conversation may be carried on over any circuit, whether made up of cables or pole lines, or both, depends:

"1. On the total electrical resistance of the circuit joining together the two stations.

"2. On the total electrostatic capacity of this circuit."

And the general rule was laid down:

"No matter what may be the distance between the two points, good business conversation may be carried on between them, provided they be connected by a pole line or cable, or both, the product of whose total resistance by its total capacity is less than 2,000, if transmitters of the Blake type be used, and less than 4,500, if transmitters of the Hunnings type be used."

It is evident, therefore, that in the construction of a telephone line it is desirable to reduce both the *resistance* and the *capacity* to a minimum.

In a pole line, since the wire is suspended high above the earth, the capacity is always small, and the resistance is the factor that we must try to keep down.

In cable lines, however, where the conductor is necessarily brought near to other conductors, or a metal shield, or the earth, the capacity becomes quite an important factor to be respected.

In lines made up, as is most generally the case, of a comparatively short section of cable and a larger section of iron pole wire, the capacity of the cable becomes pre-eminently the factor to be respected; for, since the limit of conversation is here determined by the product of the capacity of the cable and the resistance of the whole line, a small percentage of saving in the capacity of the cable gives an enormous gain in the readiness with which conversation may be carried on over the line.

* "Novum Organum," 1620.

† "Advancement of Learning."

‡ "Cosmos."

§ History of the Inductive Sciences."

‖ Drinkwater's "Life of Galileo."

¶ "Two Treatises, in the One of which the Nature of Bodies, in the other the Nature of Man's Soule is looked into; in Way of Discovery of the Immortality of Reasonable Soules." Paris, 1644.

** Thomson's "History of the Royal Society." London, 1812.

†† "Introduction to the Literature of the Fifteenth, Sixteenth, and Seventeenth Centuries."

* Epitaph on his monument in the church of the Holy Trinity, Colchester.

† "Letters of John Chamberlain." London, 1861.

‡ *Ibid.*

§ "Histories of the Worthies of England," endeavoured by Thomas Fuller, D.D. London, 1662.

‖ Presented to the American Academy of Sciences, December, 1889.

It becomes of vital importance, therefore, to choose an insulating material for telephone cables of low specific inductive capacity.

We have accordingly measured the electrostatic capacity of a considerable number of substances used for insulating wires in cables, and, since the specific inductive capacity for the same insulator is very different for telephone currents from what it is for telegraph currents, because the charge and discharge take place so much more frequently, we have adopted a method and apparatus in which currents of telephonic frequency are used.

This apparatus is a Gordon induction balance (see Gordon's Electricity and Magnetism, p. 110), in which the substances were charged and discharged by currents from an induction coil, and the balance was observed with a telephone instead of an electrometer.

With this apparatus, we measured the specific inductive capacity of a considerable number of insulating materials, and each when subjected to various rates of charge.

We found that the capacity varied very materially with the rate of charge, some substances increasing and others decreasing, but no general rule was evolved.

We found that measurements of the capacities of telephone cables made by the ordinary galvanometric measurements gave no indications of the comparative merits of these cables for telephonic work.

Finally, we made an accurate series of measurements of the specific inductive capacity of the following substances, when submitted to actual telephone currents. The values might perhaps be called the "telephonic specific inductive capacity," leaving the expression "telegraphic specific inductive capacity" to indicate values measured in the old fashioned way.

TABLE OF SPECIFIC INDUCTIVE CAPACITIES, MEASURED BY TELEPHONE CURRENTS.

Petroleum (Brooks cable)	1·6
Solid paraffine	2·0
Cotton saturated with paraffine in vacuum (Faraday cable)	2·0
Cotton boiled in paraffine (Patterson cable)	2·6
India rubber	3·7
Artificial gutta percha (Gwynn)	3·9
Gutta percha	4·2
Glass	4·6
Water	6·3

An inspection of this table shows that so far as capacity is concerned, petroleum is the best substance to be used, and doubtless this would be the case were it possible to keep it free from water; but water, we see from the table, has a specific inductive capacity of 6·3, so that its presence in the petroleum raises the capacity from the lowest to the highest in the list.

This observation is borne out by actual experience with "Brooks" cables in telephony. When new, and the petroleum dry, it works excellently; but as water finds its way in, the cable rapidly loses its efficiency for telephonic work.

This action of the water is quite different from its action as a *conductor* to produce leakage, for the loss of electricity due to leakage in a Brooks cable that has lost its efficiency from the presence of moisture is entirely insufficient to account for the deterioration.

Next to petroleum, solid paraffine is seen to be the best substance to use; but on account of mechanical difficulties it has never been found practicable to coat wires directly with solid paraffine.

If the wires are wound with cotton and then boiled in paraffine, as they are in making "Patterson" cables, the specific inductive capacity is raised to 2·6, an increase of 30 per cent., which we have seen is a very great detriment.

If, however, the wires are wound with cotton, and the air and moisture removed by the aid of heat and a vacuum, and they are then boiled in paraffine, from which the air and moisture have also been removed by heat and vacuum, the specific inductive capacity again falls to 2·0, which is the same as that of solid paraffine. This is the process used in preparing the "Faraday" cable.

It is possible that the inferiority of the Patterson cable as compared with the Faraday is due largely to the moisture retained in the cotton, which we have seen has a capacity of 6·3.

Leaving the paraffine cables, rubber is the next best, then gutta percha, and poorest of all is glass; but all of these substances have so high a specific inductive capacity as to entirely unfit them for telephonic work.

Rogers Laboratory of Physics, November, 1889.

ELECTROLYTIC HEAT.

AT a recent meeting of the Berlin Physical Society, Professor Planck spoke on the development of electricity and heat in dilute electrolytic solutions. It has become possible to subject the occurrences in electrolytic solutions to mathematical investigation, owing to the existing conceptions of the osmotic pressure in such solutions, of the more or less complete dissociation of the electrolyte when in dilute solution, of the applicability of the gaseous laws to such solutions, and owing to the experimental determination of the rate at which the ions travel. Professor Planck submitted a general case, in which the solution is not quite uniform, to a mathematical analysis, and deduced formulæ which represent that which is taking place in each unit of volume of the highly diluted solutions in which dissociation is complete. These formulæ correspond exactly to those arrived at by Nernst for the development of electricity.

Up to the present time the thermal phenomena in dilute electrolytic solutions have not been fully dealt with. The speaker showed that heat is the most important form of energy existing in the solution. It is only possible to arrive at a complete understanding of the heat production if, when drawing parallels between dilute solutions and gases, a further step is taken, and it is assumed that just as gases become warmer by compression and colder by a fall of pressure, so also heat is developed in electrolytic solutions when the ions are increased in number, and disappears when they are diminished per unit of volume. Hence the more diffusive processes in an electrolytic solution whose composition is not uniform must develop an osmotic heat, that makes its appearance, and can be calculated in the absence of any electrical current. This osmotic heat must be taken into account, along with the two already known sources of heat production, during the passage of an electric current through a solution, before it is possible to calculate all the relationships of energy in a dilute, non-uniform, electrolytic solution during the passage of a current through it.

EDISON'S PHONOGRAPH, ITS HISTORY AND DEVELOPMENT.*

By EDWARD H. JOHNSON, of New York City.

HAVING been associated with Mr. Edison in the laboratory and out of it almost constantly for the past twenty years, I am necessarily more or less familiar with everything he has done. The phonograph, however, is an invention with which I am particularly familiar. Therefore it would seem appropriate that I should comply with the request of your chairman and say a few words to you on that subject. At first he only called upon me to explain the operation of the instrument, the principle upon which it acts, and to that I assented. Then he broadened out his request, until finally he wishes me to go somewhat at length into the history of the instrument and the whole subject. To do Mr. Edison justice, and to do myself justice, I could not well do that. I have agreed, therefore, simply to relate the circumstances under which the phonograph had its origin, to explain the instrument to you, and then call upon the gentlemen who have the device in charge to operate it for your benefit.

When Professor Bell brought out the magneto telephone, with which you are not only familiar but which your children now know, Mr. Edison conceived the idea of amplifying the voice of the telephone, so to speak, by producing a transmitting apparatus which would generate a much stronger current than Mr. Bell's instrument did, and thus by operating upon Mr. Bell's instrument as a receiver, produce a much more audible and distinct vocalization, and render the instrument of much wider commercial value. It was in the course of these experiments, which ultimately led to the carbon telephone transmitter, now universally used throughout the world, and which you all recognize as the instrument to which you address yourselves when you are speaking in the telephone—it was in the course of his experiments with that instrument that he conceived the idea of the phonograph. It did not dawn upon his mind, or, for that matter, upon the minds of any of us associated with him at the time, just what he had done—produced a talking machine. He remarked to me one evening, when he was pressing his finger lightly against the diaphragm of a telephonic instrument, and feeling the vibrations, "Johnson, if I were to put a needle in the center of that diaphragm and make a point there—an indenting point like the point on the old time Morse telegraph register—then draw a slip of paper or other easily impressed substance underneath the needle, the vibrations of that diaphragm would be accurately recorded on the paper." Being an old telegraph operator myself, I immediately saw the force of that apparently not very sage remark, and I said, "Certainly, but what of that?" "Well," he said, "if we take that paper and start afresh with it, and draw it under the point of that needle or diaphragm, put a slight tension on it and pull the needle, it will follow the ins and outs of these indentations that naturally would be in the diaphragm precisely as it did move when it made the original indentations." I said, "That is true, but what of it?" "Well, only this—that would be a telephone repeater. Of course, if I speak in the telephone and that produces a vibration on the receiving telephone's diaphragm, the receiving instrument is made to record these indentations on this piece of paper, and that paper is afterward drawn under the needle, the diaphragm revibrated, without the action of the human voice, I have only to make that second diaphragm another transmitter, and I will carry my message on again to another station. Thus, instead of telephoning within the limit of the capacity of a single instrument, I will telephone to those limits, and then automatically repeat the speech over another circuit to the limits of the second circuit. In other words, I will make a telephone repeater that will be the exact counterpart of the telegraphic repeater, so well known in general use. I said, "It looks feasible; it looks practicable." That was the end of it for the time being. Neither of us—nor Mr. Batchellor or the other laboratory associates of Mr. Edison—thought any more about it for a long time. I was in somewhat straitened circumstances at the time, as we all were, owing to the fact that we had spent some six years in developing a system of electric automatic telegraph, which we sold to our friend, Mr. Gould, who was several years paying for it and has not yet settled up entirely. The situation was that we had to look around and see what we could do to earn our bread and butter. Mr. Edison has since found a way of earning his. I had to strike out in some new direction, and it occurred to me that it would be a very good idea to go around to the leading watering places, it being summer time, and exhibit Edison's telephonic apparatus, particularly the musical telephone, describe it to the public and to those who seemed to be very much interested in those acoustic experiments of Mr. Edison and Mr. Bell at that time, and make a little money in that way. I did it by having my singers stationed in the Western Union telegraph building in New York, having my receiving apparatus in a house like this at Saratoga, Buffalo, or Rochester, four or five hundred miles from New York, and reproducing the voices of these singers to my audiences at those distant points. It was very successful. A great interest was being aroused in the subject just at that time. In the course of one of my lectures, or improvised talks, it occurred to me that it would be a good idea to tell my audience about Edison's telephone repeater, at Buffalo, which I did. My audience seemed to have a much clearer appreciation of the value of the invention than we had ourselves. They gave me such a cheer as I have seldom heard. I did not comprehend the importance of the device at the time; but the next morning the Buffalo papers announced in glaring headlines, "A Great Discovery: A Talking Machine by Professor Edison. Mr. Edison's Wonderful Instrument will Produce Articulate Speech with all the Perfections of the Human Voice." I realized for the first time that Edison had, as a matter of fact, invented a talking machine. The immediate importance to me was that this created a sensation, and I had very large audiences in all my entertainments thereafter. Realizing that, and having had sufficient experience by this time to profit by such things, I made a special point of this feature in my next entertainment, which was at Rochester, and I had a crowded house—one that did my heart good—and my pocket, too. That satisfied me that I had better go home and assist in perfecting this instrument. I knew from my own experience in the matter that it was a comparatively simple thing to do, so I canceled thirteen engagements and went back home with these newspaper clippings. I went straight down to the laboratory, which was then at Newark, and I said: "Mr. Edison, look here. See the trouble you have got me into." He read these things over and said: "That is so; they are right. That is what it is—a talking machine." I said: "Can you make it?" He said, "Of course. Have you got any money?" I says, "Yes; I have a little," and I had—a little. He says, "Go to New York and get me three feet of Stubs' steel an inch and a half in diameter, and get me a piece of brass pipe four inches in diameter and six or eight inches long, and we will make it." I took the next train to New York and got the material, and took it back and went to work. Within twenty-four hours we had a little revolving cylinder turned with a crank and a simple diaphragm needle, which I will explain presently, wrapped a sheet of tin foil around the cylinder, and gave it the original phonographic sentence, "Mary Had a Little Lamb." Then we set it back to see what the instrument was going to do about it. It came out to our perfect satisfaction. Not as clear as it does to-day, but it was "Mary Had a Little Lamb," sure enough. That was the original phonograph and the starting point of an invention which, notwithstanding all that Mr. Edison has done since, notwithstanding my high appreciation of what he has accomplished, notwithstanding the commercial value—the vastly greater relative commercial value—of his subsequent inventions, is to my mind the greatest thing he ever did, and which, as a matter of fact, is the invention which has carried Mr. Edison's fame and name outside of the comparatively limited technical circle in which he was then known throughout the civilized world. (Great applause.) To-day the simple announcement that somebody, it makes no difference who he may be, known or unknown, is going to make a few remarks about Edison—that simple announcement is quite sufficient to crowd the largest auditorium with the most intelligent members of any community in this country or abroad. And I speak from experience when I make that statement.

Now, a few words in explanation of this instrument, and then you shall hear it. In the first place, there is a mistaken idea as to the character of the instrument. It is popularly supposed to be an electrical instrument, because it is the invention of the greatest of all electrical inventors. It is not an electrical instrument at all. It is a mere bit of mechanism; it is a mechanical arrangement, pure and simple. It is necessary to have a revolution of the cylinder, and to get that mechanical motion you must have some motive power. As I explained, the original machine was turned by hand. Others have been turned by water motors, gas motors, etc. This instrument on the platform, I see by the electric cords, is operated by an electric motor. That is a matter which has no significance in relation to the machine; it is merely the motive power to turn the instrument, and is no part of it. The instrument is simply mechanical. Its principle is this: When I speak, I throw the air into vibration of a given form. That strikes upon the ear and produces on the auditory nerves certain sounds, or rather they convey to the brain certain sensations that we term sounds. These sounds are infinite in variety, but they have an intelligent meaning to the brain, that meaning being simply a matter of education. It follows, therefore, that if I can produce these vibrations on the air, by other than my voice, but precisely and identically these vibrations, I will produce upon the ear, and consequently upon the brain, precisely the same sensations, and they cannot mean anything else in the one instance than in the other.

This invention is nothing more or less than an instrument which will accurately receive and record those vibrations, and retain their character, form, and number with absolute precision, and then mechanically do the work by operating something which will contribute again to the air all those peculiar waves of the vocal chords of precisely the character and form of the vibrations that it originally received. If it can be done, you will of course at once perceive that the instrument, although a bit of mechanism, if it has the capacity to reproduce these vibrations, necessarily has the capacity to produce upon the brain precisely the same sound that the vocal chords produced in the first instance. Therefore what we want is an instrument that will do that. Now let us see how we make an instrument of that kind. You take anything, no matter what, a piece of paper like this (indicating), and utter a sound, the musical note "do" for instance, and in touching it with your finger on the opposite side, you feel the vibration. Very well, we will call that the diaphragm—a paper diaphragm. We will put that in a suitable frame, and hold it in such a position as we want to. Then we will attach to the center of that diaphragm—because the center is the point of the greatest amplitude and the greatest vibration—a needle, not a sharp-pointed needle, but a needle whose point is comparatively sharp, one that will not scratch, but will simply produce the indentations upon that yielding substance. Take and arrange that in such a way that the needle of the diaphragm rests against the surface of the revolving cylinder. Now, we will put around the revolving cylinder that substance—paper is a little too hard for the needle to indent, of course; tinfoil is much better, and it was therefore used for a long while, so we will say tinfoil for the time being. We will put around that cylinder a sheet of tinfoil, and we will adjust this instrument so that the needle will press slightly against that tinfoil. Now, we will revolve the cylinder with a screw attachment at the end, so that the cylinder shall go past, transversely, in front of this needle, very gradually, so as to present a constantly new surface of tinfoil to the needle. When you speak against the diaphragm and cause a vibration of the needle while the tinfoil is passing in front of it, you will necessarily produce on the tinfoil indenta-

* Read at the recent Kansas meeting of the National Electric Light Association.

tions of precisely the same number, and of a depth corresponding to the amplitude of vibration of the diaphragm, exactly the same as the diaphragm yields, and that will yield precisely the same as the air yields that has been put in motion by the voice. Consequently, you have an absolute record on the tinfoil of the vibration of the air affected by the vocal chord, not only in number, but of the same character in all other particulars.

Now, if you will reverse this action, this cylinder, send it back again, turn it backward, if you please, then drag the needle back again, on to these indentations precisely where they began, and do nothing but simply rotate that cylinder so as to cause the needle to traverse the ground over again, thus going in and out of all the little indentations, you get precisely the same effect upon the diaphragm as you had originally; because, it now being moved by the rough path, so to speak, which it previously created, it must necessarily follow the same ups and downs. So that you get the diaphragm in motion again as it was before, with the net result that the diaphragm contributes to the air precisely the same movement that the air had sent out from the diaphragm. Consequently you get perfectly articulated speech. That is all there is to the instrument.

This instrument lay dormant for twelve years. Mr. Edison went from his telephone experiments immediately into electric light experiments, and consequently gave no attention to the phonograph, always saying to those of us who would urge him to take the matter up: "When I get through with this, I will take the phonograph up; that shall be the next thing." But the electric light came along, and before he got through with the carbon transmitter he took that up, and the phonograph was ignored. Then he promised to take it up when the electric light matter was settled. Before he had satisfied himself with his work in that direction, others took up the phonograph and worked on it to considerable purpose, namely, Messrs. Taintor and Bell. They endeavored to make a phonograph, which was then merely a scientific novelty. In other words, to do for Edison's phonograph what Edison did for Bell's telephone, make it a commercial as well as a scientific success. They succeeded in developing what has proved to be the correct principle; namely, that instead of making indentations in this plastic substance, wax, which is now the thing used, they made a little cutting knife, and actually cut the material out with each vibration.

The result of that was an instrument which, while it did not speak and was not intended to speak in the original voice, as the old tinfoil phonograph did, yet spoke with such distinctiveness that if you placed the tubes to your ear, while the voice was low, it was wonderfully clear and the utterance was easily comprehended. They brought out on the basis of that improvement what is now universally known as the graphophone, which is simply the phonograph turned the other way around. They did not claim to have anticipated Mr. Edison in this great discovery. They simply claimed to have perfected Mr. Edison's instrument and thus brought it into the realm of commercial utility; but they did not make the progress that they expected, and Mr. Edison then took the subject up again, and the result of his efforts in that direction was the perfected phonograph. Consequently we now have the graphophone and the phonograph.

A very shrewd gentleman in New York, recognizing the great possibilities of this thing, went to work to acquire the ownership of both. Consequently the North American Phonograph Company to-day is the owner of all the rights of the graphophone and the phonograph, and now being but one common instrument, the aim in this instrument is to give you all that is known of the last and best development of this wonderful apparatus, which is to record what we say, keep it for any length of time, and then reproduce it for any purpose we may wish with as perfect a retention of the character and quality of the original voice as the telephone of to-day in its best form. We will now endeavor to hear the instrument (applause): and I want to say that this instrument, although it is fitted up here with a rather elaborate contrivance so that you may hear it, is designed expressly not to do that which we are going to call upon it now to do, namely, to talk loud. It is designed to address itself to the individual ear. That is because the instrument is intended for commercial use. I do not want the message or letter which I have dictated in my study at home and sent to the office to have transcribed by the typewriter to be heard by everybody in the room; consequently the instrument is designed to speak in a low, clear tone to the ear. We can make them speak as loud as we please, but at some loss of clearness of articulation. Inasmuch as it is impossible for everybody to assemble around the instrument, we will endeavor to make the instrument speak loud enough for you all to hear.

The phonograph was then brought into action, and after reproducing several cornet solos by Levy, reproduced the following message from Mr. Edison:

FROM THE LABORATORY OF THOMAS A. EDISON,
ORANGE, N. J., Feb. 7, 1890.

Edwin R. Weeks, Esq., Kansas City, Mo.

MY DEAR MR. WEEKS: When I had the pleasure of meeting you at my laboratory in December last, you suggested that I should send to the Kansas City convention, which commences next week, a phonograph discussion upon the subject of my five-wire system of distribution, which you were good enough to assure me would prove of interest to the delegates, and ever since that time I have been trying to find an opportunity to prepare the data.

My failure to do so has been through no fault of yours, as your letters have constantly kept the matter before me, nor has it been through want of inclination on my part that I am obliged to substitute this explanation.

Certain urgent matters of business which I was unable to anticipate have occupied my attention to such an extent that I have even had to neglect the important work of my experiments.

While I could not have contributed to the success of the convention, which is already assured through its location in your enterprising city, I regret that I am unable to send something which would at least be more interesting than this apology.

Yours very truly, THOMAS A. EDISON.

IMPROVED WIRE COVERING MACHINE.

THE machine which we illustrate in Fig. 1, and in front elevation and part section in Fig. 2, and partial transverse sectional view in Fig. 3, is expressly designed to effect the covering of wire for electrical purposes.

A machine of this class is usually constructed with several heads or sections, each of which is independent to a large extent of the rest. One of these will be described. On the driving shaft, J, which extends along the machine, a number of disks, M, are keyed, there being one to each machine head. Adjoining each disk, and to a certain extent covering it, is a grooved disk or pulley, N. One side of this disk is hollowed and has a circular leather plate fixed in it, which acts as a frictional surface by which N is driven when pressed up to M. Over the pulley an endless band, K, is passed, the course of which is shown by the dotted lines in Fig. 3, and which drives the two rotating spinning heads, B and C, in opposite directions. The grooved disk can be slid upon a shaft by means of the lever, F, by moving which the left contact of the frictional surfaces is established, or *vice versa*. The wire is drawn from the reels, A—shown in place at the upper part of the machine in Fig. 1—and is passed through the hollow spindles of the spinning head, after which it follows the course down until it reaches the draw roller, E, on which it is taken a complete turn. The rate of rotation of the draw roller regulates the speed of covering, and the reels, G, upon which the covered wire is wrapped, are driven by a band from the shaft on which the draw roller is fixed, so that the speeds of the two are relatively proportionate. The covering material is carried in spools fixed upon pins fastened in the face of the spinning disks, L. Instead of driving the shaft, O, and draw roller by bevel gearing, they are driven by a worm and worm wheel, the former being fixed on the driving shaft. In this way a regular speed of traverse is obtained, entirely free from the irregularities arising from back lash when ordinary gear wheels are used. This is important for the reasons previously given. The stop motion consists of a small finger, U, attached to the spinning disk in such a way that as the latter is rotated the finger tends to assume a perpendicular position. It carries an eye, through which the yarn is passed, the tension upon the latter being sufficient to prevent the finger from taking the position named. As soon as the end falls the finger assumes the perpendicular, and in its rotation strikes one end of the small lever, V, which is oscillated through an arc of 90 deg. The movement communicated to V causes the part, X, to descend and press a small weight, D, which is suspended by a cord in a slot of the lever, B. On the latter is a projection, in front of which the weight is forced, and is thus brought into the path of a cam on the driving shaft. In this way the lever is pressed back, and by means of the connecting rod, S^1, it raises and releases the lever, F^1, so that it can be drawn over by a spring, and the section is thus stopped in the manner previously described. To restart the machine it is necessary to piece up the thread and restore the small lever, V X, to its original position. This is done by a small lifting rod, Z, specially provided and arranged to act for both disks.

The machine we have described has been found to possess many advantages, and an important works in the neighborhood of Manchester has been fitted with it. It is capable of larger turnouts than other machines, owing to the regularity of its working and the rapid stoppage of the heads, which obviates winding back and facilitates piecing. The covering can be guaranteed to be satisfactory, and the cost of labor is reduced by each head being worked automatically. The makers are Messrs. Thomas Barraclough & Co., limited, of Manchester.—*Industries.*

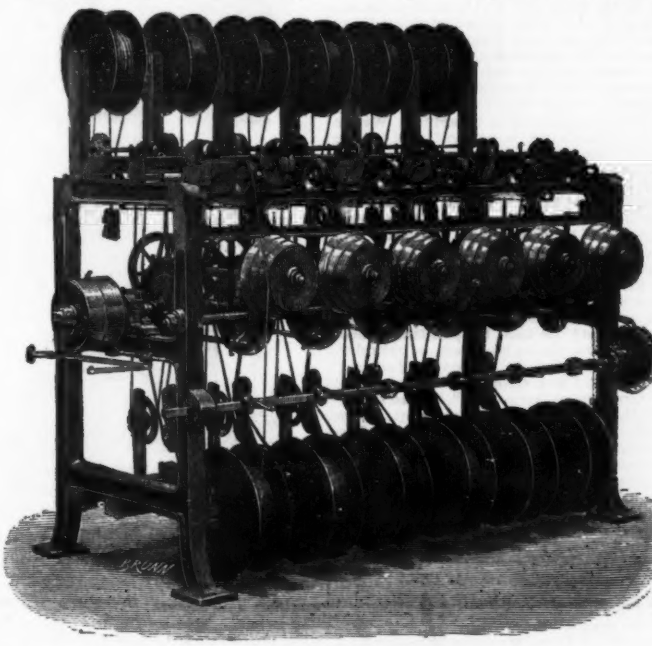


FIG. 1.—GENERAL VIEW.

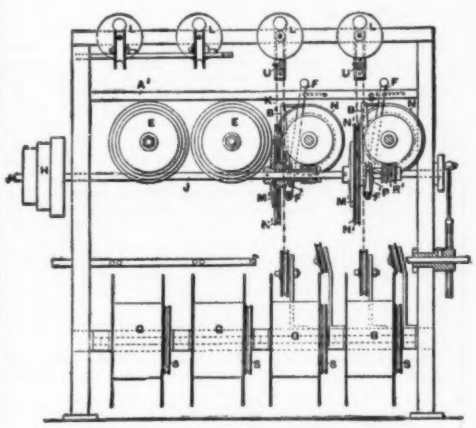


FIG. 2.—FRONT ELEVATION.

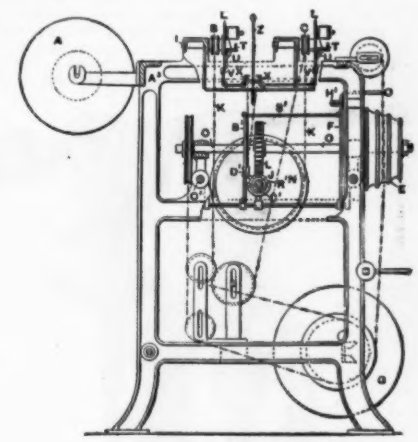


FIG. 3.—END ELEVATION.

IMPROVED WIRE COVERING MACHINE.

A NEW INDIGO VAT.

WE are pleased to notice the introduction of a patent indigo powder by Mr. J. Cowan, of Glasgow, which promises to create a revolution in this branch of dyeing.

In five minutes any one may now have a genuine indigo vat, by simply adding to hot water in an iron or zinc vessel heated by fire, "dumb" or unperforated steam pipes, or a steam jacket or casing, equal quantities—by weight—of patent indigo in the form of prepared powder and liquid bisulphite of soda. After boiling for a minute or two, put off boil, and let dye liquor settle for several minutes. It will then have a pure yellowish green appearance, with a coppery film on the surface, and dyeing is conducted in the clear liquor, procedure as regards handling, squeezing, and airing being practically the same as by old processes.

A dye liquor, prepared as above directed, but subject to modifications of temperature as detailed in the next paragraph, will dye wool, silk, cotton, and linen to any desired shade, and in one or more operations, according to concentration. In place of about 120° Fahr., as hitherto for woolen work, and cold for cotton and linen, the following heat may be employed in dyeing with this new vat: For unspun wool, 180° to 200° Fahr.; for woolen piece goods and light serges, 150° to 180° Fahr.; for woolen yarns, 130° to 160° Fahr.; for silk, 120° to 160° Fahr.; and for cotton and linen, 120° to 150° Fahr.

As there is no lime in this patent indigo powder, no necessity arises for those vexatious delays between dyeings, at present required when fresh stuffs are added,

five minutes sufficing with this new vat for dye liquor to clear, after fresh indigo and bisulphite have been stirred in. In large dyeworks such stuff may be conveniently added to vat as required, from a stock kept ready boiled up in seperate boiler, and prepared as instructed in paragraph 1, but in a concentrated form. This arrangement allows vat liquor to be kept at the heat suited to the class of work in hand. It follows, therefore, that the total absence of lime from this new vat permits of continuous dyeing in it, the importance of which fact will be at once apparent.

In dyeworks where a large daily output is imperative, great economy in plant—and consequently in space—is effected by the use of this patent indigo, as its power of continuous dyeing enables one vat to equal, or even exceed, the production of several under old methods. In the case of cold-dyed cotton and linen yarns, a series of vats is at present indispensable, but by this new process one vat gives any shade of blue wished, and in one or more "runs" or "dips," in dyer's option. Unspun wool dyed in this vat is beautifully soft, elastic, and uniform in shade, while piece goods and yarns are better penetrated by the color, owing to the higher dyeing heat available. For the same reason they are much more easily and cheaply cleaned.

It may be stated here with regard to scouring and sulphuring, that such blues are in these respects entirely satisfactory, and also, that under prolonged exposure to light and the severest weather conditions, they remain absolutely unchanged. Cotton cloth, yarn, and thread treated in this vat—as also all linen products—are unusually level ... shade, and well dyed through. Such blues are very fast to soaping, and far excel cold-dyed blues in resistance to bleaching. Warps or "chains" are dyed to shade in one vat, and in one continuous operation, thus saving time and labor, and keeping the fiber agreeably soft. Being extremely clean, these blues when woven into white goods can be calendered direct from loom without staining the fabric, unlike cold-dyed blues, which are so imperfectly fixed on the fiber as to necessitate elaborate precautions being taken ere calendering can proceed, to protect goods into which they are woven from being soiled during the process. Fast greens of all shades for shipment are also readily obtained in this vat.

When prepared as a paste, it will be found that the patent indigo powder may be used for printing calico, or other tissues and fibers, either by block or cylinder, and in conjunction with colors for "steaming styles." These indigo prints stand the strongest steaming and soaping, without blurring or "running" in the slightest degree on the fabric, which requires no preparation beyond that given for steaming colors. Pure indigo blues, dyed in this new vat, give the genuine indigo reaction with nitric acid, and stand all "government" or other usual tests, whether acid or alkaline. The customary "bottomings" and "toppings" used for indigo work on wool, woolen goods, cotton, and linen, may all be employed with this patent indigo.—*Chem. Tr. Jour.*

[Continued from SUPPLEMENT, No. 742, page 11851.]

PORCELAIN MANUFACTURE IN FRANCE.

FIG. 1 is employed specially for making cups, and closely resembles some of those we have already published. On the vertical spindle, the top of which carries the mould, is a fast-and-loose pulley, the arrangement for throwing the strap off and on being controlled by the pedal. The template is attached to the counterbalanced lever at the top of the machine, and is raised and lowered by the handle. A disk of clay is applied round the inside of the mould and the lever is depressed so that the template presses against the in-

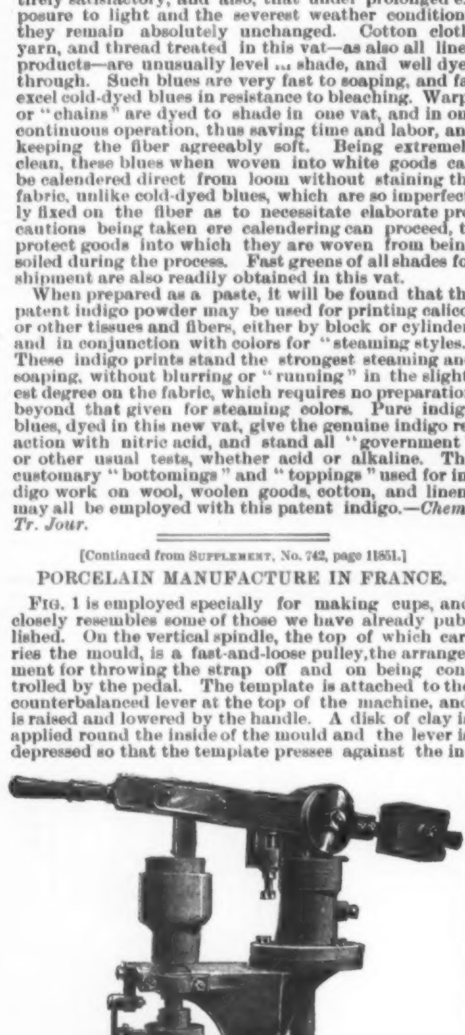


FIG. 1.—CUP MAKING MACHINE.

ner face of the clay; the machine is then started, and the clay is formed into its permanent shape by the template removing the superfluous material. Fig. 2 is a machine for making hollow and incurved forms. The clay is previously rough-moulded in another machine similar to that for making blanks, already described; only instead of these blanks being flat, they are formed around a plaster mould, the shape of which resembles that of a flower pot. This mould is placed on the table of the blank-making machine, and is covered with linen; a ball of clay is then placed on the top, and is worked down over the sides. When this has been done the mould covered with clay is placed in the mould mounted on top of the vertical spindle of the machine shown in Fig. 4, and the plaster mould with its linen cover is lifted out, and the machine is started. The template on the balanced lever is formed to the contour of the vessel which is to be made, and has a reciprocating movement which can be regulated by the cam mounted on a spindle that traverses the template

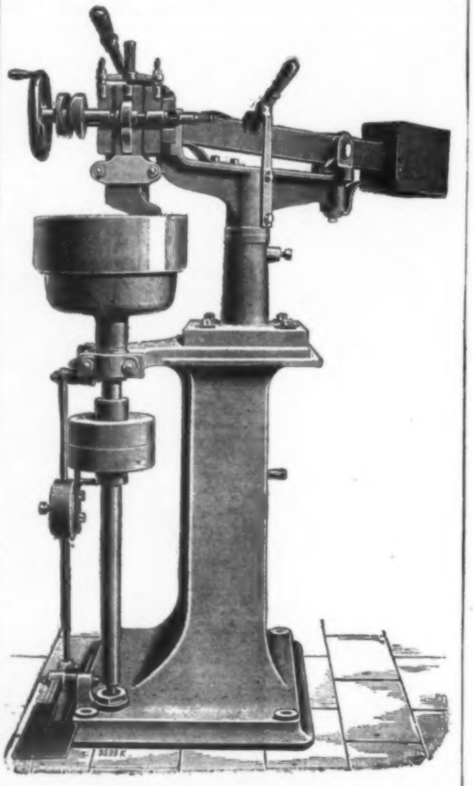


FIG. 2.—MACHINE FOR MOULDING GLOBULAR OBJECTS.

holder. The amount of movement is regulated by the handwheel. By altering the form of the mould any desired shape can be produced. In order to take out the finished vessel, it is necessary to make the mould in two pieces.

Fig. 3 is a very ingenious potter's lathe, in which, by a simple device, any desired variation in speed can be obtained without stopping the work, and which, owing to its freedom and smoothness in running, appears specially well adapted to the work to be done. A large friction disk on the pulley shaft drives a second disk by friction on the vertical spindle carrying the work; on guide bars on the side of this spindle is a rack into which gears a toothed quadrant, the arm of which, hung on a center, is counterbalanced. To this arm is hung a vertical lever articulated at the upper end to a short lever mounted on a shaft, which is connected with a treadle. In the position shown no motion would be imparted to the upright spindle, but, by turning the quadrant, and thus raising the rack, the motion would be increased gradually to a maximum; the rack and driving disk are free to slide upward, so that the level of the vertical spindle is not affected. The machine for making the plaster mould is shown by Fig. 4. It consists of a holder containing the mould, which is mounted on a vertical spindle and driven by a strap and an overhung fixed tool holder, to which any sort of cutter can be adapted.

The machine shown in Fig. 5 is one of the most curious of the series, and is used for making oval dishes,

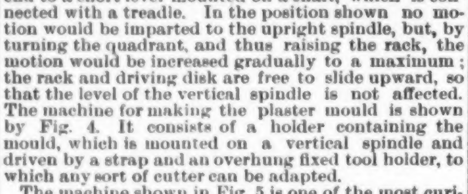


FIG. 3.—POTTER'S LATHE WITH VARIABLE SPEED.

the thickness of which varies in different parts. The standard carrying the mould is mounted on a slide rest, which is free to travel to and fro at right angles in guides beneath; the eccentric motion necessary to produce the desired form is obtained by this double slide arrangement, a large range for adjustment being allowed for producing flatter or fuller ovals. Of course the shape of the mould has to correspond with the adjustment of the sliding bed plate.

In order to vary the thickness of the dish in different parts of its surface, the template is attached to a curved lever hinged to the frame and carrying at its lower end a roller that bears on a cam path revolving with the mould; the form of this cam path is such as to give increased or diminished thickness to the object where required.

A great many of these machines are in use in France; their daily output is 100 dishes of medium size. The other machine, Fig. 6, is, in different sizes, a necessary one for preparing the disks of clay to be afterward

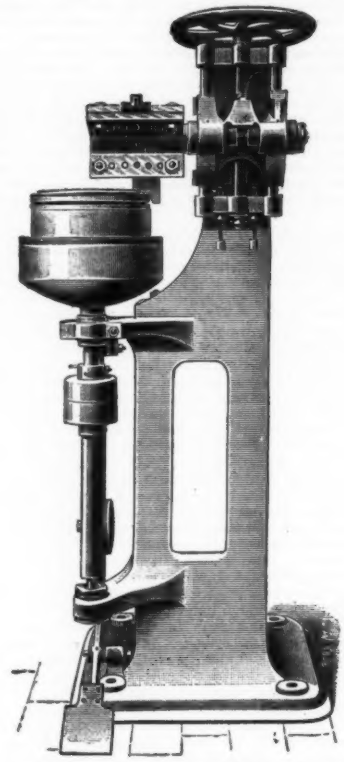


FIG. 4.—MACHINE FOR MAKING PLASTER MOULDS.

worked into different forms for various purposes. A lump of clay of the size required is placed on the revolving table, and the block is pulled down upon it, spreading it out and reducing it to a disk of uniform thickness, when it is ready to be placed upon any of the other machines and converted into cups, basins, or other vessels.

In concluding this notice, we may add a few facts about the porcelain and *faience* industry of France. The porcelain industry in that country dates from the

FIG. 5.—MACHINE FOR MAKING OVAL DISHES.

end of the last century in Limousin and in Paris, while in Berry it was commenced nearly ninety years ago. A great development has taken place since 1840, having doubled in Limousin and quadrupled in Berry since that date. The growth, however, has been due to the extension of existing works rather than to the creation of new ones, with one important exception—that of Haviland & Co.

The material worked up in the Berry factories comes chiefly from the department of Allier, and to a very

limited extent from Limousin and England; refractory clays are plentiful in the neighborhood. In Limousin such clays do not exist, and are brought from considerable distances; the porcelain clays are obtained in the Haut Vienne; raw material and coal costs about 25 per cent. more than in Berry. In the latter district about sixty furnaces are kept in constant work, and in Limousin there are one hundred, but of smaller dimensions.

The Faience works of Choisy le Roi, Seine (MM. Boulenger & Co.), are very important; they were established in 1804, and have a capital of about 3,000,000 francs. On the works are engines of 160 horse power and eighteen furnaces. The annual consumption of clay is about 7,000 tons, of which that for *faience* comes from Cessoy; and the kaolin is obtained from Allier, Brittany, and Decize (Nievre). The consumption of coal is 8,000 tons a year, and 2,500 tons of clay for furnaces, etc., are used. The number of workmen is about 1,000, and the weekly output is 350,000 pieces, or 18,000,000 a year.

Until recently the manufacture was devoted to the supply of home demand, but about four or five years since the company commenced the extension of their business in foreign countries. The following are the export figures relating to 1887 and to 1888:

Spain, 80,000 pieces; Italy, 40,000; Roumania, 40,000; Russia, Turkey, and Egypt, 80,000; the Eastern South American States, 100,000.

The sales for last year exceeded 2,500,000 francs, about three-fifths of which are sold in Paris, the proportions being as follows: Paris, 1,500,000 francs; exportation, 300,000 francs; French provinces, 700,000 francs.—*Engineering.*

INSTRUMENTS FOR DRAWING CURVES.

By Prof. C. W. MacCord.

NO. V.—THE ROULETTE SPIRALS.

If we imagine an inextensible string, without thickness, to be unwound from a cylinder, and kept always taut, the extremity of the string, or, indeed, any point upon it, will trace the involute of the circle which forms the base of the cylinder. But if the string is always taut, it is always straight; consequently a rigid ruler, rolling around the cylinder without sliding, may be substituted for it, and the ruler may have a pencil fixed either in the contact edge, or at any distance from it, which will trace a spiral curve whose properties will vary according to the distance of the pencil from the edge.

The instrument shown in the accompanying illustration is simply such a ruler, with proper provision against sliding, and with the addition of a means of properly guiding the blades of a drawing pen in the direction of the tangent to the curve, should it be desired to draw the curves in ink.

The base of the cylinder is represented by the fixed wheel, W, and the ruler by the rack, R R. In order to keep the rack in gear, a groove, *g g*, is formed on its upper side, in which slides a lip projecting downward from the limb, L, whose axis of rotation is C, the center of the wheel. The rack, R R, is connected at its ends by transverse pieces to a parallel bar, R′ R′, which is provided with a flange, against which bear the two rollers, *r r*, whose axes are carried by the limb, L, and the lower faces of R and R′ move in contact with the disk, D, fixed to the wheel, W, the object being to secure a smooth and steady motion without springing.

Above these parts is secured a light frame, F F, carrying a transverse bar, in which is a long slot, S. In this slot slides a block, through which is drilled a bearing for the pen carrier, P, and by means of a milled nut (not shown) this block may be fixed at any position in the slot at pleasure.

The pen carrier is a cylindrical socket, formed in one piece with the bridle rod, B B, from which it projects upward through its bearing in the sliding block above mentioned. This bridle rod is of a T section, and it slides freely through a guiding socket, which is pivoted to the limb, L, at the point of contact, Q, of the pitch line of the rack and the pitch circle of the wheel. Since this point of contact is always the instantaneous axis, it follows that the bridle rod, B B, will be normal throughout the action to the curve traced by the pen, wherever it may be fixed in the slot, S.

Thus, in the position shown, Q P is normal at P to the Archimedean spiral, whose pole is C, which curve the pencil is now tracing, and Q I is normal at I to the curve I G, which would be the path of the pencil were it fixed at I. If the pencil be fixed at O, then, evidently, Q O is normal at that point to the involute, whose root is J on the pitch circle of W; in tracing this curve the bridle rod will not rotate about P, but

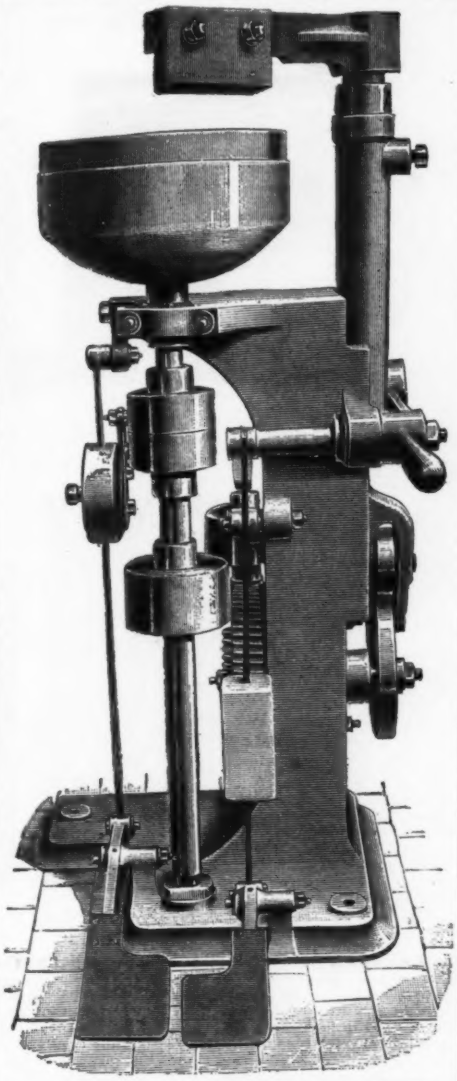


FIG. 6.—MACHINE FOR PREPARING DISKS.

will always coincide in direction with the pitch line of the rack, R, merely sliding through the socket at Q.

But, although this device is capable of drawing a number of different spirals, according to the position of the pencil, it can draw each of them upon only one scale; thus it can trace only the involute of the pitch circle of the fixed wheel, only the Archimedean spiral, whose rate of expansion per revolution is equal to the circumference of that circle, and so on. Considered merely as a draughtsman's appliance, then, its utility would be limited. But the two curves just named are often used as the outlines of cams, and the mechanical combination here given by which the motion of the bridle rod is controlled might serve a good purpose in a special tool for the shaping of such cams when numbers of them of the same size are required.

Considered in the light of a drawing instrument, again, it is to be noted that, as here shown, it would require the board to be placed over it; for that purpose, therefore, it should be inverted and suspended over the drawing board, which is not done in the illustration, as the principle of its operation, which alone we cared to make clear, is more easily seen in the position here shown.

HORSESHOES AND ROADWAYS.

The horseshoe of the present should be improved. There needs to be something which will save the hoof from an undue wear and breakage, while at the same time permitting of elasticity of movement when the weight of the body is alternately borne upon and taken from it.

The *World* suggests that an improved roadway is needed in this climate; something that will wear as well as stone, be as easy to pull on as asphalt, and give the horses' feet a good grip, so that they will not slip, even in rainy weather.

To the Editor of the Scientific American:

The above clipping from your valuable paper agrees so nearly, in one sense, with my ideas that I may be pardoned a lengthy reference thereto.

There is no doubt but that our horseshoe needs the greatest of improvement. After centuries of use we still cling to a form of shoe that is simply abominable, while in nearly all other matters we have made immense strides in our march of improvement.

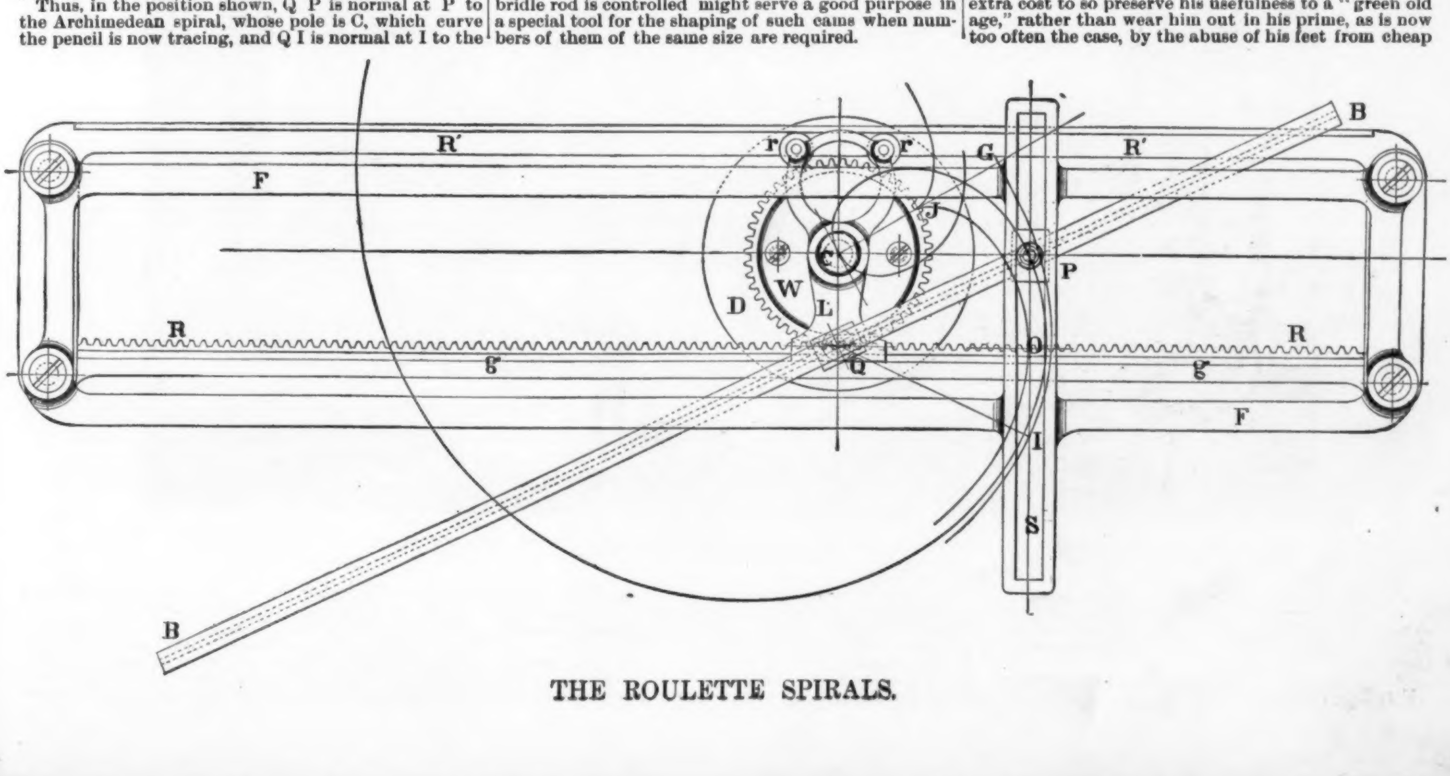
To my mind the shoe, if one is needed at all, is always made too heavy, and in nearly all cases with a flat ground surface that soon wears down smooth and gives no hold upon the ground. To remedy this the ordinary smith puts on toe and heel calks, even for every-day use on ordinary roads, and sharpens them when the roads are icy in winter, thus raising the horse up on these points of support to each foot, making him walk and work upon regular "pattens," to the great injury of the horse through the strain thrown upon his tendons.

Besides this the ordinary smith nails the shoe to the horse's foot with anywhere from five to eight nails, and thus binds the foot rigidly and prevents the "elasticity of movement" you speak of. Now, even a single nail cannot be driven into the horn of a horse's hoof without injury thereto. Let it be granted for the moment that this nail driving does not produce actual pain, it yet does destroy the structure and vitality of the horn from and between the nail holes *down* to the edge of the hoof, make it "brash," dry, and brittle, easily worn away and chipped, and in every way produces results to be deplored. Frequent shoeing soon makes at least the lower part of the hoof diseased, and in such a condition that the shoeing smith is at a loss where to drive a nail to make it hold, so he cuts away until he has cut down almost to the quick to get at new horn higher up upon which to repeat the process of destruction.

The careful carpenter or cabinet maker bores holes for the insertion of his nails or screws upon all but the roughest of work, and yet he has inanimate wood alone to deal with. Experience has taught him, however, that the firmness, accuracy, and above all the *durability* of his work are thereby insured. Driving nails or screws in wood without boring for them separates and destroys the wood fiber, and thereby brings on causes for decay, and this is even more so with the vital hoof.

Space cannot be taken for a lengthy description of the character of this horn; but it may be said that the microscope reveals its texture to be a mass of *tubes* lying parallel to each other, thoroughly compacted together, and each tube full of a moisture peculiar thereto. From this it is seen how injurious the nail driving must be, and, if shoes must be used, and consequently nails driven, why cannot the smith bore for them and thereby destroy as little vitality as possible, and at the same time give a stronger fastening, and one that can always be depended upon not to come out too high or approach too close to the inner and extremely sensitive parts of the foot.

"Costs too much," I hear one say. "'Twould need a thoroughly skilled workman," I hear another object. Suppose it does cost more, is not the value of the horse to be considered? Would it not be better to pay the extra cost to so preserve his usefulness to a "green old age," rather than wear him out in his prime, as is now too often the case, by the abuse of his feet from cheap



THE ROULETTE SPIRALS.

shoeing? And who should not be a thoroughly skilled mechanic, if the shoeing smith should not? The carpenter, the machinist, the mason, brick-layer, and stone-cutter all must "serve their time" and become skilled mechanics, and they have only inanimate matter to deal with, no nerves, veins, arteries, or live tissue to handle. But any one can go into a blacksmith shop, begin by blowing a bellows and hammering iron, and "pick up" the horseshoeing trade, and soon become shoeing smiths, with no more knowledge of what they are dealing with in all its intricate, delicate, and well balanced parts than I have of the language of the inhabitants of Jupiter; and yet we wonder why our horses' feet are not better shod, why they chip, crack, and wear out. Truly the horseshoer as well as the horseshoe needs improving.

I will not go into the many abuses arising from ignorant shoeing, but will at once say that the great remedy for all the many prevalent ills the horse's foot now endures is *to stop shoeing him at all*, and restore him to a state of nature, and let nature, aided by proper care and treatment, do all the rest.

Almost every one will at once say this cannot be done; but I speak from experience of many years with many horses when I say I know it can. I do not mean to say strip off his shoes and turn him barefooted at once to do his work, for the horse would infallibly go lame and become useless. As well expect to strip off our own boots or shoes and go barefooted anywhere with impunity. But I do mean to say that even the worst crippled horse one could select can, by proper treatment, be gradually relieved of his shoes and gradually be brought to a condition where he can stand any work upon any road, day in and day out, and be the better for it in every way.

And the process is simple enough. Insist upon it that your horse's foot be shod with lighter and lighter shoes each time he is reshod; that his foot is not cut, rashed, and burned when the shoes are set, but simply leveled and the wall cut down to receive the shoe; *get full frog pressure*, and gradually shorten the shoe at the heel until finally only a thin tip is used upon the toe; and finally this can be removed and a sound-footed and a *sure*-footed horse will be the result.

As I have said, I *know* this can be done. I am no theorist, but speak from what I have seen for years, and in every case it has been success, and no failures; and I can show any one who cares to see a herd of about sixty horses that are all barefooted, have feet like iron, and can and do work and travel on any kind of road with perfect impunity.

And there are many who can corroborate my statements from their own experience. In London, in New York, in fact, in many places, where the service is of the most severe character, horses are going sure-footed and free on their bare feet, and so far as pains and aches, lameness and unserviceability are concerned, are thoroughly sound.

And it has been proved by long experience and observation that the barefooted horse fears no kind of road, be it stone, asphalt, slush, mud, ice, or anything you can put him on. I have seen barefooted horses move at a rapid trot over icy roads where sharp-shod horses were slipping and falling, and not a slip, slide, or faltering step was made by those barefooted. This was not once, but daily through long winter seasons. The barefooted horses seemed perfectly fearless and free in their movements, while those that were shod were pictures of terror and agony as they slipped, and slid, and staggered along, fearing a fall at every step.

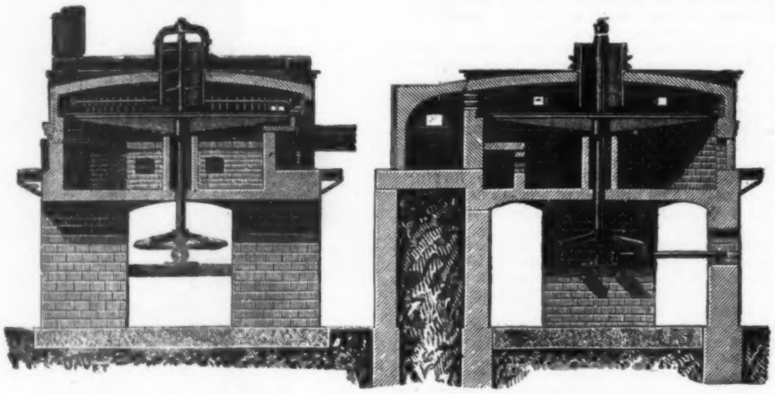
So I say, improve our horseshoe until it is only a light plate or a steel tip on the toe. Set it as carefully as you would any delicate part of a piece of fine machinery, for that is what it becomes in fact, and finally abolish it entirely, and then all the improvement possible will have been made.

C. D. PARKHURST, Lieut. 4th Artillery.

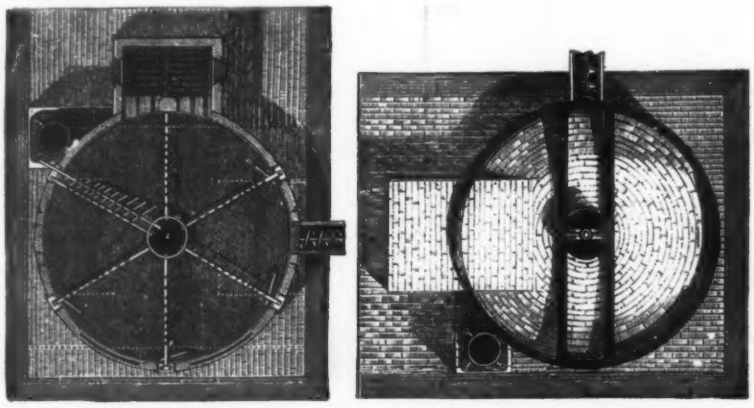
Fort Riley, Kansas, March, 1890.

FURNACE FOR DRYING COAL AGGLOMERATES.

WE represent herewith a drying furnace, which was exhibited at the Paris exposition by Messrs. Bietrix & Co., alongside of the Couffinhal machines for making agglomerates.



FIGS. 1 AND 2.—LONGITUDINAL AND TRANSVERSE SECTIONS OF THE BIETRIX DRYING FURNACE.



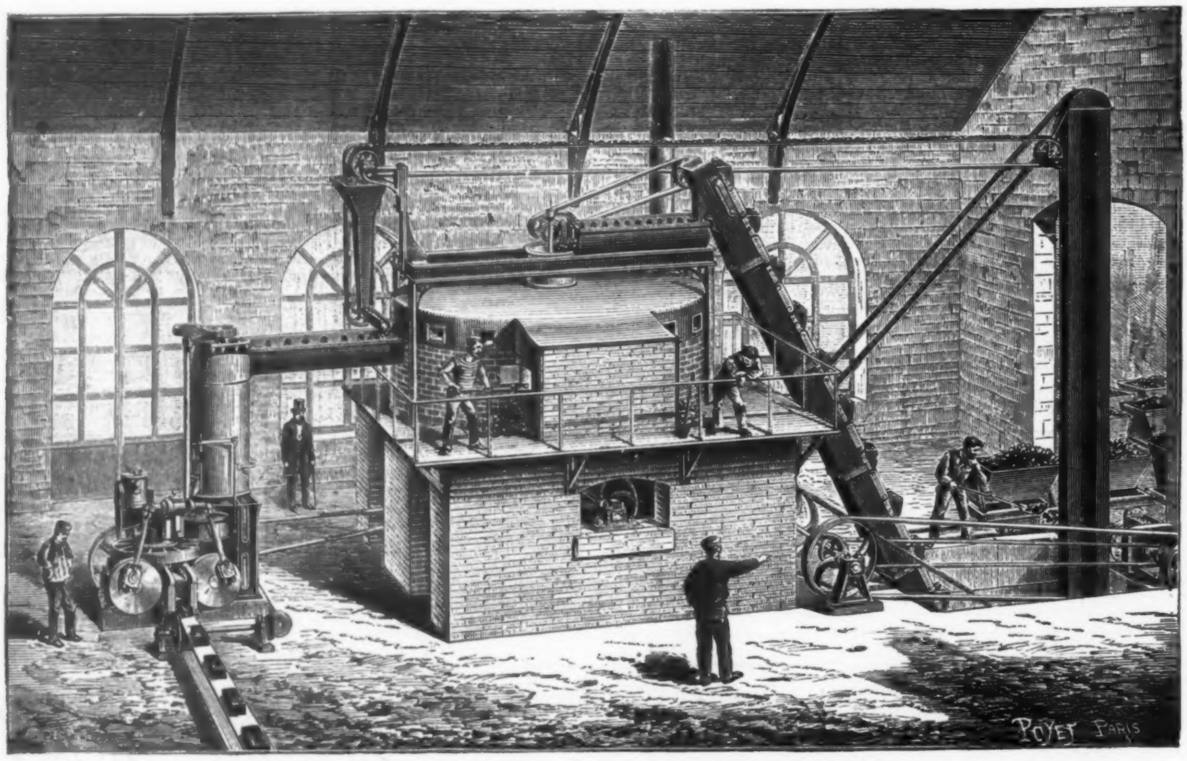
FIGS. 3 AND 4.—HORIZONTAL SECTION AND PLAN.

As well known, the compression of the paste is of prime importance in the manufacture of agglomerates, and it follows from this that a judicious selection of the apparatus for performing this operation counts for much in the final result. Yet this is but one side of the problem, for before compressing the paste it is necessary to prepare it, and to render it sufficiently plastic by the addition of a minimum quantity of resin. There has been used for a long time for this purpose, and that, too, almost exclusively, a steam kneading machine.

This apparatus has some good points. It is simple, cheap, easily kept in order, and is utilized with advantage for the melting of the resin. But one necessity arises when it is desired to employ high pressure and run the present presses rapidly, and that is that of eliminating the greater part of the water contained in the coal.

The water, in fact, spreads, through the compression, and gives briquettes that are so much the more foliated in proportion as they have been the harder pressed. Every time, then (and this is most frequently the case, since most coal designed to be agglomerated is washed) that coal is wet, it will have to be dried. Now the kneading machine is worth absolutely nothing for such an operation. It was therefore necessary to look for something else, and this is one of the reasons that led Messrs. Bietrix & Co. to devise the direct heating furnace shown in the accompanying figures.

This furnace is of circular form. It consists of a cast iron revolving platform, whose motion and that of the agglomerating machine are interdependent. This platform is surrounded with masonry, which is itself surrounded with a jacket of boiler plate, and upon it



GENERAL VIEW OF A COAL BRIQUETTE FACTORY.

rests a spherical dome that allows of the passage, through the center, of a cast iron cylinder with an axis provided with paddles.

A fireplace at the side, with two opposite doors, permits of obtaining the temperature necessary for heating the coal and the elimination of the water, if there is too large a proportion of it.

The flames, after licking the upper surface of the fine coal to be agglomerated and heating the dome (which acts by radiation), pass over the sole to the opposite side of the furnace, and thence go through a flue to the chimney.

In the jacket of the furnace there are six apertures. The first four serve for the introduction of bars provided with appendages that turn over the material, mix it, and permit it to become heated at a uniform temperature, and bring all its parts in contact with the flames and the sole. Opposite the fifth aperture there are two bars, one stationary and the other movable, which, through jointed partitions arranged after the manner of the Venetian blinds, gradually lead the material from the center to the circumference, and at the same time stir it and turn it over. Another object of this arrangement is to regulate the thickness of the layer, and consequently the time of the coal's stay upon the sole.

Another scraper, maneuvered through a rod outside the furnace, takes the material to the center, carries it to the zone of action of the preceding, and regulates the discharge.

The furnace is constructed upon a masonry foundation. The principal peculiarities of its construction are that its running is continuous and that it requires but slight motive power. The temperature obtained softens the cohesive principles of the coal, and thus effects a saving in resin. As for the consumption of fuel, that is less than in steam kneading machines.—*Revue Industrielle.*

CHRONOPHOTOGRAPHY.*

THE new chronophotographic apparatus that we are now going to make known was constructed at the works of the Central Laboratory of the Navy according to the instructions of Colonel Sebert. This apparatus, made especially in view of ballistic experiments, belongs to the class of multiple apparatus, and each of the photographic cameras that it admits of is designed to give one of the phases of the phenomenon observed.

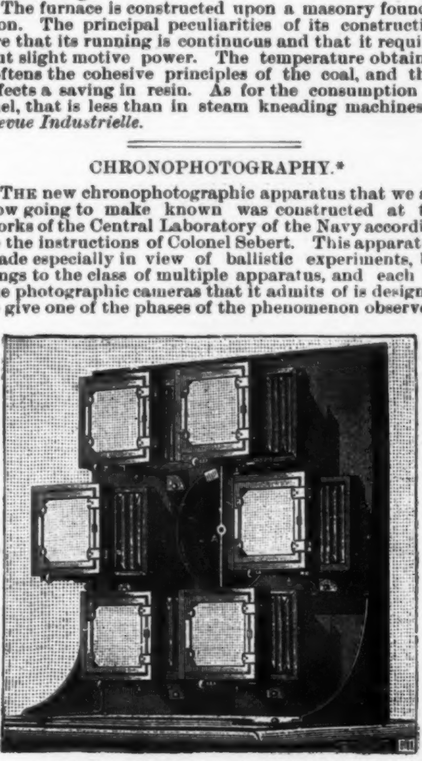


FIG. 1.—BACK VIEW OF THE CHRONOPHOTOGRAPHIC APPARATUS.

The great difficulty met with in this kind of instruments is due to the fact that it is necessary to be able to free the various shutters very rapidly in order to obtain the different negatives at sufficiently approximate instants. Instead of having recourse to electricity, as in the apparatus of Muybridge and Anschuetz, and which is always a complication, preference has been given to a purely mechanical arrangement.

The apparatus consists substantially of six cameras provided with aplanetic objectives, six shutters independent of the cameras, and a peculiar disengaging mechanism designed to actuate these shutters one after another.

The six cameras are placed, according to the angles of a regular hexagon, behind a vertical plate having windows opposite the objectives (Fig. 1). In front of this plate there is fixed a large disk, B, hollowed in the center and provided with six apertures that correspond to the windows. It is upon this disk that the shutters are mounted (Fig. 2). Each shutter has two pairs of leaves, one for uncovering the aperture and the other for closing it. Each shutter is held by a special piece, O, forming a lever. The opening and closing levers are placed symmetrically on each side of the plate, and are consequently in two different planes. When the opening lever of one of the shutters is raised, the two leaves, actuated by strong springs, I, open suddenly, and as soon as the other lever is acted upon, the other pair closes just as rapidly. In the center of the disk that carries the shutters there revolves a solid disk, B, which receives a uniform motion from a counterpoise and regulator motor. It is upon this disk that are placed the special parts that are to act at a given moment upon the levers of each shutter.

The shutter disk and its mechanism are mounted upon an independent stand, so that no vibration may be transmitted to the cameras. The assemblage between the objectives and the shutters is effected through sleeves made of a flexible fabric impermeable to the light. The obturating mechanism, moreover, is protected by a box which contains only the openings necessary for the passage of the luminous rays (Fig. 3).

This apparatus, which is designed more particularly for studies touching the military art, is employed for registering the firing of projectiles having a relatively slow motion (such as automobile torpedoes), the recoil of guns, the explosion of stationary torpedoes, etc. It is therefore provided with a special arrangement that permits of electrically controlling the phenomenon to be photographed.

* Continued from SUPPLEMENT, No. 742, page 11860.

The apparatus must, then, at the moment desired by the operator, bring about the firing, and then, after a time calculated in advance, cause the successive starting of the shutters at regulated intervals, and give the latter a known duration of action.

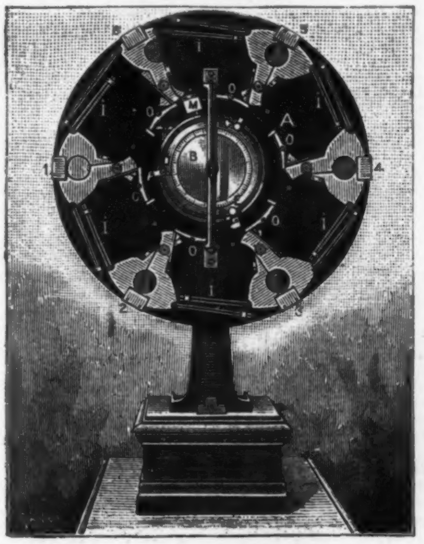


FIG. 2.—DETAILS OF THE APPARATUS.

A. Shutter disk. B. Revolving disk. C. Firing slides. D. Fixed needle for opening the shutters. E. Movable needle for closing the shutters. 1, 2, 3, 4, 5, 6. The six shutters. 1. Position of the shutter open. 2, 3, 4, 5. Shutters open to show the two parts. 6. Shutter closed and ready to open. *i, i, i, i, i.* Springs of the shutters. *o, o, o, o, o.* Levers for freeing the shutters.

These multiple results are obtained by means of different devices placed upon the circumference of the movable disk (Fig. 2). This disk is divided into 100 equal parts, and upon the zero of the graduation there is a fixed piece which is designed to cause the opening of the shutters. The two other pieces, performing the office of sliders, are capable of moving over the circumference of the disk and of being stopped opposite any division. The firing slider, C, moves in a direction opposite that of the disk in starting from zero. The further away it gets, the more the time is increased that will elapse between the firing and the opening of the first shutter.

The other slider, E, which is designed to close the various shutters in succession, moves on the other side of the zero and in the direction of the motion. The interval between the fixed pieces and this slider regulates the length of the time of exposure of the various shutters. On another hand, the speed of revolution of the disk can be modified by means of a centrifugal regulator, thus permitting of realizing all the combinations possible. In the experiments whose results will be given further along, the disk made two revolutions per second. Each division, then, corresponds to 1/200 of a second.

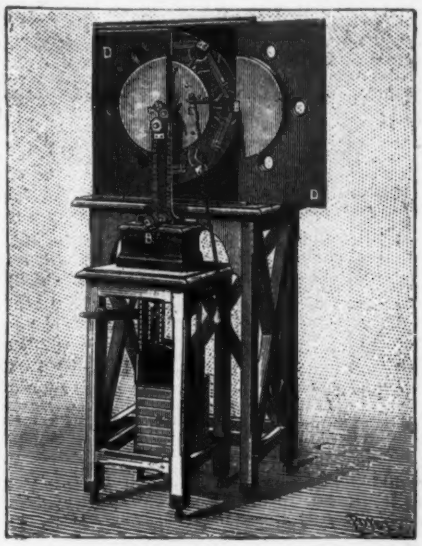


FIG. 3.—FRONT VIEW OF THE APPARATUS.

A. Counterpoise. B. Regulator. C. Gearings. D D. Plate covering the shutters.

If the firing slider makes an advance of 50 divisions, there will occur 50×1/200, say ¼ of a second, before the first photograph is taken. If, on another hand, the closing slider is at one division of the fixed slider, the time of exposure will be 1/200 of a second.

The two parts that we have just described will act upon the levers of the shutters through needles which, in a state of rest, are not in the planes of the levers, and consequently cannot actuate them. We shall see in a moment how these pieces, brought back at the desired instant to the plane of the levers, raise them one after another. Let us now examine the operation of the apparatus. The position of the slides being regulated, and the shutters closed, the central disk is set in motion. The latter, carried along by the counterpoise, gradually gets its speed, and it is not until it has acquired this that the operator presses the rubber bulb that controls the whole series of operations. As long as he has not acted, the disk revolves to no effect, as the needles of the slides are not in the planes of the

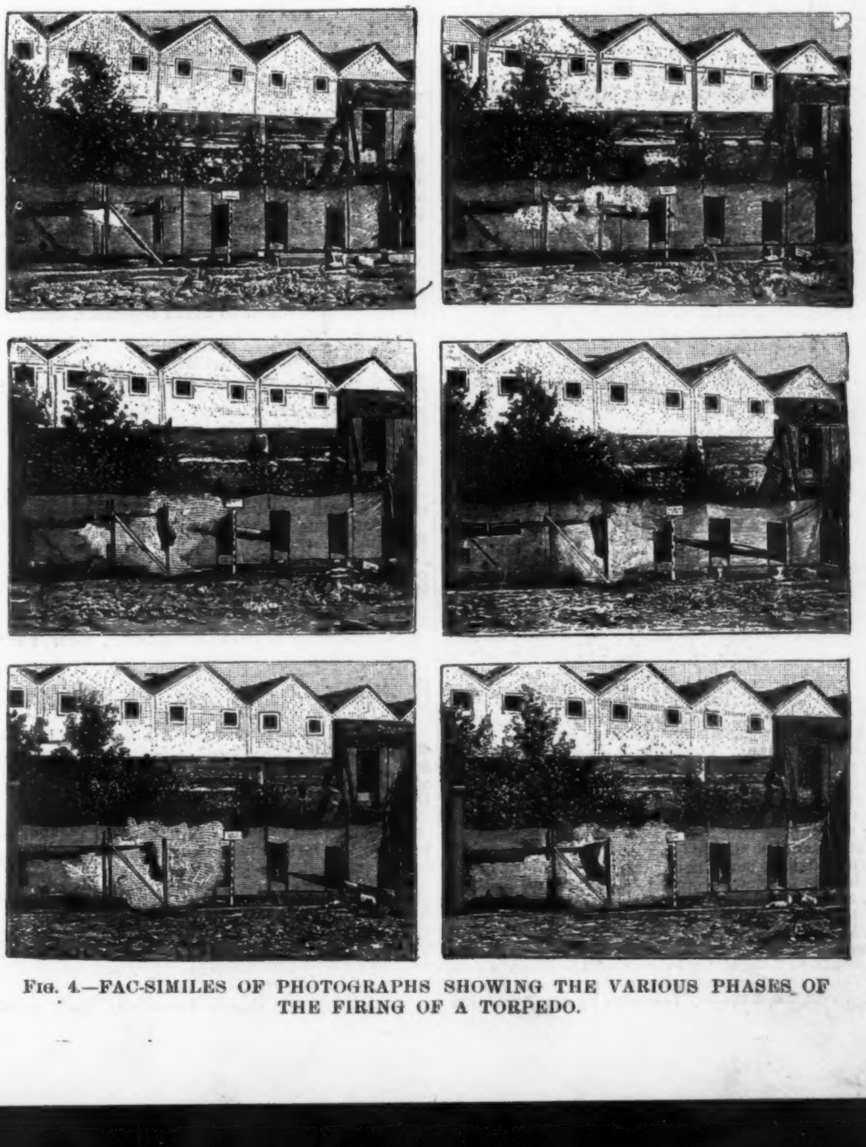


FIG. 4.—FAC-SIMILES OF PHOTOGRAPHS SHOWING THE VARIOUS PHASES OF THE FIRING OF A TORPEDO.

levers; but, as soon as he has operated, the firing is effected at the moment of the passage of the piece that controls that function, then the needles of the sliders are brought back automatically to the plane of the two systems of levers. The shutters are freed one after another, and the six photographs are taken. As soon as the last one is taken, a fixed piece frees the needles, and the apparatus continues to revolve to no effect, as before. This, the most curious part of the mechanism, is too complicated to explain without figures; suffice it to say that it solves the problem in a relatively simple and absolutely sure manner. The apparatus once regulated, the operations follow each other in the prescribed order without the possibility of any error occurring. We reproduce one of the photographs taken with this apparatus and shown at the exposition (Fig. 4). It represents an experiment in firing an automobile torpedo. As well known, this torpedo, which has the form of a fish, contains, along with a charge of gun cotton, a compressed air motor, which drives a screw, and thus gives the affair a movement of propulsion after the torpedo has entered the water.

A ship sends these torpedoes in the direction of an enemy's vessel by means of a tube that blows them to a distance of about sixty feet. After entering the water they continue on their way through the action of the screw set in operation by the launching itself. As the net cost of a torpedo of this kind is considerable, it may be conceived how essential it is that the conditions that influence the regularity of its submarine running shall be known with precision. Now, it has been found that such running does not become rapidly regular unless the torpedo reaches the water under well determined conditions. If it inclines in front more or less in plunging, the regularity of its running will be put to hazard; if, on the contrary, it falls flat upon the water, the results will be very different.

Although the velocity of these projectiles is not very great (about sixty feet per second), it is yet very difficult for the eye to take account of exactly what has occurred during the launching. The apparatus just described permits of analyzing the phenomenon with the greatest facility, and, what is more, of preserving a visible trace of it.

In the first series of photographs we see the torpedo starting from the tube, and, traversing the different panels placed in the field of firing, but gradually in-

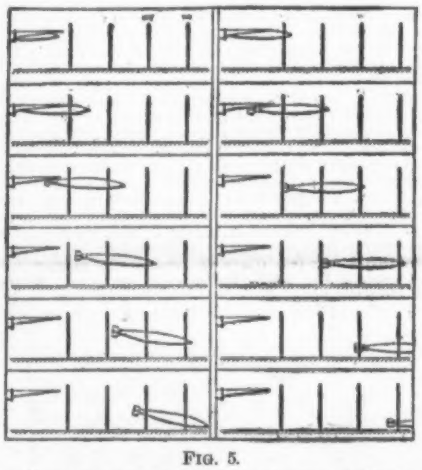


Fig. 5.

Torpedo badly fired. Torpedo properly fired

clining, falls point foremost. It has been badly fired. In the second series, on the contrary, such is no longer the case; the torpedo is maintaining itself horizontally, and, in a manner, moving always parallel with itself (Fig. 5). Under such circumstances it falls flat and starts off normally and regularly toward the object to be reached. One may easily conceive the interest there is in preserving a trace of these experiments (which last but an instant) in order to study them at leisure, and draw practical results from them.

We are just finishing the construction of a chronophotographic apparatus based upon a slightly different principle and designed for the medical researches that we are making at the Salpetrière. We hope, before long, to describe it to the readers of *La Nature* who are good enough to take the trouble to interest themselves in the articles that appear over our signature.—*Albert Londe, in La Nature.*

THE ADMINISTRATION OF CERTAIN DRUGS BY ELECTRICITY.

At the meeting of the Harveian Society, held November 7, 1889, Dr. Cagney read a paper with the above title, in which he referred to the experiments of Eulenburg, Von Bruns, and Hermann Munk, who had shown that certain drugs can be made to pass through animal tissues between the poles of a galvanic current (*Lancet*, December 21, 1889). He had used iodide of potassium in this way for the cure of labyrinthine deafness and in lead palsy. Only very small doses, however, can be administered through the skin. The method is best adapted for the treatment of diseases of the skin itself or tumors immediately beneath, and of mucous membranes. The indications are those for the local use of iodine and iodide of potassium. In affections of the throat, syphilitic and simple, and especially in chronic pharyngitis, it is very useful. Nodes and gummata in accessible situations seem to yield steadily to it; and this is equally true of tubercular ulcers in the later stages of syphilis, mucous patches, and papular syphilides. Among non-specific affections it serves well in the treatment of indolent ulcer, lupus, and acne, and to promote absorption in enlarged glands of scrofula. Benefit might be expected also in bronchocele and exophthalmic goitre. The method seems to possess certain advantages. By its employment it is possible to administer in perceptible doses a drug which is among the most useful we have—a drug, moreover, which is not readily tolerated by every constitution, and in a manner which is least likely to disturb the system. It is conveyed directly to the part where its action is needed, and presumably in a nascent state, that is, a state of maximum activity. Finally, the lesion, if it be due to errors of nutrition, or if, as in metallic poisoning, it be attended with paralysis, is at the same time benefited by the stimulating action of the galvanic current. In the application of the method great current strength is not needed. It is current density which is requisite, and the tissues under treatment must be brought directly in the path between the poles. The electrodes may be either sponges holding solution of iodide of potassium or a modification of Dubois' conducting tube filled with the fluid. The latter gave the best results in Munk's physiological experiments, and doubtless they are to be preferred where the skin has to be penetrated. They should then be of large size. For the treatment of mucous surfaces an electrode may be made of a glass tube, which can be filled with fluid, having a zinc wire introduced through the bottom, and the mouth (cut to any desired curve) blocked with a fine sponge. This is connected, by means of the zinc wire, with one pole of a galvanic battery. The electrodes should be of large surface area. The fluid should be a saturated solution of iodide of potassium, and it ought to be applied, where possible, at both poles. Where this is not possible, the solution should be at the negative pole. The current should be passed for ten or fifteen minutes, and its strength will be determined by circumstances. Its direction should be reversed every minute. This is important, and it is one reason why both poles may be charged with advantage. Under suitable conditions the positive pole may be carried by a gold needle, which is plunged in a convenient situation beneath the skin. This expedient serves especially in the treatment of strumous glands, and perhaps of bronchocele. By its means the obstacle arising from the depth or inaccessibility of the part under treatment may sometimes be overcome.—*Therapeutic Gazette.*

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